

EXAMINED



State of Connecticut

REPORT

OF

The Connecticut Agricultural
Experiment Station

NEW HAVEN, CONN.

FIFTEENTH REPORT OF THE STATE ENTOMOLOGIST, 1915

W. E. BRITTON, PH.D.

BEING PART II OF THE ANNUAL REPORT OF 1915

FIFTEENTH REPORT
OF THE
STATE ENTOMOLOGIST
OF
CONNECTICUT
FOR THE YEAR 1915

BY
W. E. BRITTON, PH.D.
State Entomologist

New Haven, Conn.

1916

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NOTE REGARDING AUTHORSHIP.

For bibliographical purposes all matter in this report not bearing the name of some other author, should be credited to W. E. Britton.

ILLUSTRATIONS.

With the exception of XI, c, which is from a drawing by Mrs. E. L. Beutenmüller, and used in the reports for 1909 and 1912, all plates are from photographs: I, II, b, III, b, IV, b, and VI, a, by W. E. Britton; II, b, by I. W. Davis; III, a, by Thomas Kenney; V, b, by Q. S. Lowry; IX by M. P. Zappe; all others by B. H. Walden.

All text figures are from drawings by B. H. Walden except in figure 1; the map was drawn by A. E. Moss of the forestry department, the quarantine line and lettering being added by Mr. Walden.

PART II.

FIFTEENTH REPORT

OF THE

State Entomologist of Connecticut

To the Director and Board of Control of the Connecticut Agricultural Experiment Station:

I have the honor to submit herewith my fifteenth report as State Entomologist of Connecticut for the fiscal year ending September 30, 1915. Some of the nurseries have been inspected and their certificates issued since that date, but it is desirable to include them all in one list. Two important entomological developments of the year are, the new law relating to the gipsy and brown-tail moths, and the discovery of the presence of a destructive European pine sawfly, *Diprion simile* Hartig, in Connecticut. These, with a large number of less important matters, are discussed in the following pages.

Respectfully submitted,

W. E. BRITTON,
State Entomologist.

REPORT OF THE RECEIPTS AND EXPENDITURES OF THE STATE ENTOMOLOGIST
FROM OCTOBER 1ST, 1914, TO SEPTEMBER 30TH, 1915.

Insect Pest Account.

RECEIPTS.

From E. H. Jenkins, Treasurer	\$4,250.00
Account of 1914, balance	500.53
State Comptroller, Apiary Inspection Account	15.40
Gypsy Moth Control Account	7.18
	\$4,773.11

EXPENDITURES.

For Field, office and laboratory assistance:

B. H. Walden, salary	\$1,500.00	
Q. S. Lowry, salary	750.01	
I. W. Davis, salary	200.00	
M. P. Zappe, salary	375.00	
Frances M. Valentine, salary	440.00	
Grace A. Foote, salary	178.33	
Other assistance	62.00	
		\$3,505.34
Printing and illustrations	19.20	
Postage	50.01	
Stationery	11.18	
Telegraph and telephone	1.77	
Office supplies	25.68	
Library	102.52	
Laboratory supplies	47.71	
Express, freight and cartage	3.05	
Rental and storage	7.00	
Tools and supplies	61.19	
Traveling expenses	176.92	
Balance, cash on hand	761.54	
		\$4,773.11

*Gipsy Moth Control Account.**

RECEIPTS.

From E. H. Jenkins, Treasurer	\$8,000.00	
Account of 1914, balance	2.39	
Ford Motor Co., Rebate on car	50.00	
I. W. Davis, Use of car	5.00	
		\$8,057.39

EXPENDITURES.

For salaries, board of scouts, etc.:

I. W. Davis, salary	\$ 866.64	
Q. S. Lowry, salary	249.99	
M. P. Zappe, salary	525.00	
Other assistance, labor, etc.	1,918.38	
Board of scouts	784.11	
		\$4,344.12
Printing and illustrations	8.55	
Postage	13.46	
Telegraph and telephone	22.23	
Office supplies	36.30	
Express, freight and cartage	150.31	

* Including cost of inspecting imported nursery stock.

Rental and storage	\$ 38.00
Insurance	75.83
Tools and supplies	2,815.33
Traveling expenses	553.26
	\$8,057.39

Memorandum:—These accounts of the State Entomologist have been duly audited by the State Auditors of Public Accounts.

SUMMARY OF INSPECTION AND OFFICE WORK.

- 287 samples of insects received for identification.
- 77 nurseries inspected (some twice).
- 74 regular nursery certificates issued.
- 3 parcels of nursery stock inspected and certified.
- 28 orchards and gardens examined.
- 264 shipments, containing 1,349 cases, 2,102,222 plants imported nursery stock inspected.
- 57 shipments found infested with insects or fungi.
- 494 apiaries, containing 4,241 colonies, inspected.
- 129 apiaries, containing 441 colonies, found infested with European foul brood.
- 4 apiaries, containing 8 colonies, found infested with American foul brood.
- 10 apiaries, containing 20 colonies, found infested with sac or pickled brood.
- 2147 letters written on official work.
- 642 post cards written on official work.
- 228 circular letters sent out.
- 276 reports of inspection to Federal Horticultural Board.
- 1866 bulletins, etc., mailed on request or to answer inquiries.
- 90 packages sent by mail or express.
- 24 lectures and addresses made at institutes, granges, etc.

PUBLICATIONS OF ENTOMOLOGICAL DEPARTMENT, 1915.

By W. E. Britton:

- Fourteenth Report of the State Entomologist (Part III. of Station Report for 1914) : 86 pages, 16 plates, 6 text figures; 10,000 copies distributed in April.
- Bulletin 186, "The Gipsy Moth," 24 pages, 16 figures; 12,000 copies distributed in April.
- Report of Committee on Injurious Insects, Proceedings Connecticut Pomological Society, page 23, 4 pages, 1915.
- Report of Entomologist, Society of American Florists and Ornamental Horticulturists, Boston meeting, page 189, 3 pages, 1 plate, February, 1915.
- Report of Entomologist, Society of American Florists and Ornamental Horticulturists, San Francisco meeting, printed in *Florists' Exchange*, Vol. XL, page 537, 1 column, September 4, 1915.

Bulletin State Board of Health, "The Mosquito Problem of Connecticut and How to Solve It," 16 pages, 9 figures, July, 1915.

"Anti-Mosquito Work in Connecticut": *Proceedings of the First Annual Meeting of the New Jersey Mosquito Extermination Association*, page 63, 9 pages, February, 1915.

"The Academic Training of the Entomologists in Colleges and Experiment Stations of the United States": *Journal of Economic Entomology*, Vol. 8, page 72, 7 pages, February, 1915.

"A Simple Record System for Apiary Inspection": *Journal of Economic Entomology*, Vol. 8, page 121, 2 pages, February, 1915.

"A Destructive Pest of Pine Trees Introduced from Europe, *Diprion (Lophyrus) simile* Hartig": *Journal of Economic Entomology*, Vol. 8, page 379, 3 pages, 1 plate, June, 1915.

Review of "Manual of Fruit Insects" by M. V. Slingerland and C. R. Crosby: *Journal of Economic Entomology*, Vol. 7, page 408, 1 page, October, 1914.

"Prevalence of *Macrosargus cuprarius* Linn. in the United States": *Psyche*, Vol. XXII, page 29, 2 pages, 1 figure, February, 1915.

"A Pest of Shade Trees, The White-marked Tussock Moth": *Tree Talk*, page 6, 2 pages, 2 figures, May, 1915.

Eliminating Cutworms: *Florists' Exchange*, Vol. XL, page 536, 1 column, September 4, 1915.

Correspondence Slip "Cutworms," Revised edition, 1,000 copies, May, 1915.

"Insects as Carriers of Disease," Proceedings Third Connecticut State Conference of Charities and Correction, Waterbury, April 14-16, 1912, page 147, 10 pages, published 1914.

Chapter on Insect Pests "The Potato as a Cash Crop," Joint Circular of Information No. 1 (Agricultural College and both Stations of Connecticut), 1 page, March, 1915.

"Summer Work against the Brown-Tail Moth," 2 columns, 3 figures, published in *Windham County Observer* (Putnam), May 5, and the *Putnam Patriot*, May 7, 1915.

By W. E. Britton and G. P. Clinton:

Bulletin 183, "Spray Calendar," 28 pages, 63 figures, on folding card printed on both sides; 13,000 copies distributed in January, 1915.

Bulletin 184, "Spray Treatment, etc., for Orchards," 12 pages, 1 figure, 10,000 copies distributed in January, 1915.

By B. H. Walden:

"Mosquito Control Work": *Saturday Chronicle* (New Haven), 1¼ pages, 2 figures, February 13, 1915.

ENTOMOLOGICAL STAFF.

W. E. BRITTON, Ph.D.	<i>State and Station Entomologist.</i>
B. H. WALDEN, B.Agr.	<i>First Assistant.</i>
QUINCY S. LOWRY, B.Sc.	<i>Assistant.</i>
IRVING W. DAVIS, B.Sc. ..	<i>Assistant and Deputy in Charge of Moth Work.</i>
MAX P. ZAPPE, B.S.	<i>Assistant.</i>
MISS FRANCES M. VALENTINE*	<i>Clerk and Stenographer.</i>
MISS GRACE A. FOOTE, B.A.†	<i>Clerk and Stenographer.</i>

Mr. Walden has been in charge of all work during the absence of the Entomologist, has done most of the photographic work of the department, has helped inspect nurseries and imported nursery stock, and as time permitted conducted investigations, identified insects and worked on the collections.

Mr. Lowry has assisted in the inspection and general work of the department, has conducted a series of experiments in an attempt to control the cabbage maggot, and has made observations on other insects attacking cabbage and other vegetable crops.

Mr. Davis has also helped in the inspection of nurseries and imported nursery stock and has been in charge of the field work in suppressing the gipsy and brown-tail moths. Mr. Davis spent a greater part of the winter in charge of scouting crews in Stonington and North Stonington. On the passage of the new law he was appointed assistant and deputy in charge of this work, and during the summer until August 7th, superintended the spraying and other field work in the eastern end of the state.

Mr. Zappe during the winter scouted for gipsy moth eggs with Mr. Davis and the remainder of the year has served as general assistant. During the summer he has been in charge of the insectary and the breeding and collection records, and has helped inspect nurseries and imported nursery stock. He has given considerable time and attention to a study of the distribution, life history and habits of *Diprion simile*.

Mr. Matthew H. Stanley, a member of the gipsy moth force during the summer, was employed for five weeks in August and September to help inspect nurseries.

Messrs. H. W. Coley of Westport and A. W. Yates of Hartford, as formerly, have inspected apiaries on a *per diem* basis.

* Until June 20, 1915.

† From June 22, 1915.

Mr. P. L. Buttrick has been employed as a special agent of the Station under the direction of this department to make a mosquito survey at the mouth of the Connecticut River and to prepare a report thereon.

Miss Frances M. Valentine, who for three years served as clerk and stenographer in this department, on account of gradually failing health was obliged to give up her work about June 20th; she continued to fail and died September 17th. Miss Valentine had the benefit of a long experience in the keeping of office records and systems and was particularly efficient in this part of the work. She was extremely faithful, often working beyond her failing strength, and was cheerful and courageous to the end.

Miss Grace A. Foote, who comes to the department with a thorough training and considerable experience, has done the necessary clerical and stenographic work since June 22d.

All members of the staff have worked energetically and conscientiously. Whatever has been accomplished during the year is therefore due not to any one in particular but to all, and the Entomologist wishes to here express his appreciation to all for their faithful and efficient services.

NEW EQUIPMENT.

New bookshelves have been installed which give 49 linear feet of additional shelving for books. A low-power Bausch & Lomb binocular microscope was purchased for use in studying insects in the laboratory. For the moth work, as has been mentioned elsewhere, were purchased a Ford touring car, an Indian motor cycle, and a Fitzhenry-Guptill high-power sprayer with the necessary hose and nozzles.

CHIEF LINES OF WORK.

The inspection of nurseries and imported nursery stock and the routine and control work continues to occupy a large portion of the time and attention of members of the staff. Especially during October, when most of the shipments of *Azalea indica* arrive, and also in November, December and January there are constant arrivals of imported nursery stock. In March and April, perhaps, the greatest rush comes.

During August and September all men are needed in making the annual inspection of nurseries.

The gipsy and brown-tail moth suppression work has also taken much time and attention. This, in charge of Mr. Davis, will hereafter be placed on a different basis, as provided in the new law. Nevertheless, the Entomologist will continue to have general charge, must make rules and regulations, approve all accounts, etc. Though all bills are to be paid by the State Comptroller, it will be necessary for the State Entomologist to keep records about the same as before.

Considerable attention has been given to the pine sawfly, *Diprion simile* Hartig, in an attempt to learn of its present distribution in Connecticut, and to ascertain its habits, food preferences, and seasonal life history. Mr. Zappe has done most of this work under the direction of the Entomologist, though he has been aided somewhat in the field by Messrs. Lowry and Walden. An account of this insect will be found in this report.

Successful experiments in controlling the cabbage maggot were conducted by Mr. Lowry at the Station farm at Mt. Carmel, and minor tests were also made at A. N. Farnham's. Mr. Lowry has also made observations on other insects attacking cabbage and vegetable crops.

A general entomological supervision has been given the Station orchards at Mt. Carmel. Some of the spraying work, more especially as regards the old apple orchard, has been in coöperation with the botanical department. The young peach and apple orchards have been examined for borers, and the apple trees treated for aphids.

Mr. Walden has continued his experiments and observations on the control of the white pine weevil and has made a number of visits to examine pine plantations and to give advice regarding insects attacking the trees.

Mr. Walden and Mr. Buttrick, special agent, made a mosquito survey of Stonington, and are making records of the changes which take place in the vegetation of a salt marsh after and on account of draining. Mr. Buttrick has also made a survey of the mosquito-breeding areas at the mouth of the Connecticut River and his report was published as Bulletin 189, and is included in this report. The expense of making this survey and of pub-

lishing the report as a bulletin was borne, in part, by the Old Saybrook Town Improvement Association.

The Entomologist and Mr. Walden have both examined marsh areas and have given advice regarding treatment, and have attended meetings to answer questions and explain the habits of mosquitoes and how to abolish the nuisance.

Mention should be made of the occurrence of three species of scale-insects not hitherto recorded from the state; of the juniper web-worm; the larch sawfly; two psyllids and a weevil from Europe, all of which are described in greater detail in the following pages.

Exhibits were made this year at two agricultural fairs, Norwich, September 6-8, and Berlin, September 14-17. These were in charge of Mr. Zappe.

Bulletin No. 22 of the Connecticut Geological and Natural History Survey, "The Hymenoptera of Connecticut," which is now in press, has required considerable attention especially in reading proof and preparing the index. The manuscript of another bulletin of the Survey, "A Check-List of Connecticut Insects," which was submitted more than four years ago, and which will soon go to press, required revision on account of many additions and the rearrangement of certain groups caused by recently accepted changes in classification.

INSPECTION OF NURSERIES.

Commencing August 16th, the work of inspecting the growing stock in the nurseries of Connecticut was carried along rapidly and was finished October 11th. This work was done by Messrs. Walden, Lowry, Davis, Zappe and Stanley. All worked together in the larger nurseries, but separated in examining the smaller ones.

The Ford car proved very useful in inspecting nurseries, particularly the larger ones. Four or five men could be transported to and from the nursery at much less expense than is possible by railroad, and by taking an early start it was found possible to get in a good day's work and to be home again fully as early as under the old system. No time was wasted in waiting for trains or trolley cars or in walking from them to the nurseries

and back again. The motor cycle was also used by Mr. Zappe for a part of the inspection work and proved efficient and particularly useful where one man only was needed, as is the case with some of the small nurseries. It was found especially convenient where the nursery is not near a steam or trolley road. The use of these two motor vehicles must have saved the department several hundred dollars this season in this work alone.

On account of the possible presence of the pine shoot moth, *Evetria buoliana*, the imported pine sawfly, *Diprion simile*, the pine blister rusts, the chestnut blight, and certain other pests, the annual inspection each year, especially of the woody plants, has been growing more and more rigid, and particular attention has been given to certain species which formerly were never or seldom found infested. The inspection of 1915 was especially rigid. On the whole the nurseries were in good condition. In 31 nurseries no pests were found; in 27, traces of San José scale, only two having infestations that could be called serious. Oyster shell scale was found in 24; scurfy scale, 5; tulip scale, 6; pine leaf scale, 4; West Indian peach scale, 2; spruce gall louse, 2; euonymus scale, 1; linden borer, 1; lilac borer, 2; and chestnut blight, 4.

In all cases the infested trees or plants were suitably marked and reported to the owner with written orders regarding destruction or treatment. No certificates were issued until these instructions had been carried out.

In addition to the inspection of regular nurseries, a certain number of requests are received each year for the inspection and certification of small lots or packages of scions, shrubs, etc., that some one wishes to send away and cannot do so without such inspection and certification. During the year 3 such inspections have been made and in each case a certificate has been issued.

One nursery has been inspected twice, and two or three were inspected before we learned that the owner had gone out of business. Thus altogether 77 nurseries were inspected during the year and 74 certificates granted.

The list of nurserymen this year contains 72 names, the same number as last year. Six have discontinued the nursery business and six new ones have started. The list of nurseries for 1915, with date and number of each certificate, is as follows:

NURSERY FIRMS IN CONNECTICUT RECEIVING CERTIFICATES IN 1915.

Name of Firm	Address	Certificate Issued	No. of Certificate
Barnes Brothers Nursery Co.	Yalesville	Sept. 27,	670
Beattie, Wm. H.	New Haven	Oct. 11,	699
Bowditch, J. H.	Pomfret Center ...	Sept. 27,	665
Brainard Nursery & Seed Co. ...	Thompsonville	Oct. 4,	688
Bradley, H. M.	Derby	Jan. 8, '16,	722 ^m
Braley & Co., S. A.	Burnside	Oct. 5,	690
Bretschneider, A.	Danielson	Sept. 27,	666
Brooks Bros.	Westbrook	Sept. 28,	672
Burroughs, Thos. E.	Deep River	Oct. 2,	685
Burr & Co., C. R.	Manchester	Aug. 31,	652
Chapman, C. B.	Groton	Oct. 7,	694
Chapman, C. E.	North Stonington..	Sept. 10,	655
Comstock & Lyon	Norwalk	Oct. 13,	703
Conine Nursery Co., The F. E. ..	Stratford	Oct. 1,	681
Conn. Agricultural College (Prof. A. G. Gulley)	Storrs	Sept. 27,	664
Conn. Agr. Experiment Station, (W. O. Filley, State Forester)	New Haven	Sept. 24,	663
Conway, W. B.	New Haven	Sept. 23,	661
Cross Highway Nurseries	Westport	Oct. 6,	692
Dallas, Inc., Alexander	Waterbury	Dec. 13,	718
Dehn & Bertolf	Greenwich	Oct. 8,	697
Dowd, Frank C.	Madison	Dec. 1,	715
Elm City Nursery Co., Woodmont Nurseries, Inc.	New Haven & Woodmont	Sept. 30,	676
Fairfield Landscape & Nurseries Co.	Cannon Station ...	Oct. 2,	684
Gardner's Nurseries	Cromwell	Sept. 21,	659
Geduldig, G., Estate of	Norwich	Oct. 7,	696
Hartford Park Commissioners (G. A. Parker, Supt.)	Hartford	Nov. 3,	710
Heath & Co., H. S.	Manchester	Aug. 31,	654
Hilliard, H. J. (2)	Sound View	Nov. 3,	709
Horan & Son, Jas.	Bridgeport	Oct. 2,	686
Houston & Sons, J. R.	Mansfield	Dec. 17,	719
Hoyt's Sons Co., The Stephen ...	New Canaan	Oct. 8,	698
Hubbard & Co., Paul M.	Bristol	Oct. 5,	689
Hunt & Co., W. W.	Hartford	Oct. 11,	700
Intravaia, Joseph	Middletown	Sept. 21,	658
Kelley, James	New Canaan	Sept. 20,	656
Kellner, Herman H.	Danbury	Oct. 2,	682
Kelsey & Sons, David	West Hartford ...	Oct. 11,	701
Long, J. A.	East Haven	Sept. 30,	677
Mallett & Co., G. A.	Bridgeport	Sept. 29,	675

Name of Firm	Address	Certificate Issued	No. of Certificate
Maplewood Nursery Co. (S. Hart- ridge, Mgr.)	Norwich	Oct. 26,	708
McDermott, E. F.	Windsor	Oct. 1,	680
Meier & Gillette	West Hartford ...	Oct. 1,	679
Munro, Charles	New Haven	Sept. 23,	662
New Haven Nurseries Co.	New Haven	Oct. 13,	702
New Haven Park Commissioners (G. X. Amrhyh, Supt.)	New Haven	Nov. 12,	714
New London Cemetery Associa- tion (F. S. Newcomb, Pres.) ..	New London	Oct. 7,	693
New London County Nurseries (W. J. Schönman, Prop.) ...	New London	Jan. 4, '16	720
Northeastern Forestry Co.	Cheshire	Aug. 31,	651
Oakland Nurseries	Manchester	Aug. 31,	653
Palmer, L. M.	Stamford	Sept. 27,	669
Park Gardens	Bridgeport	Sept. 29,	674
Phelps, J. Wesson	Bolton	Nov. 12,	712
Phelps & V. T. Hammer Co., The J. W.	Branford	Nov. 12,	711
Pierson, Inc., A. N.	Cromwell	Sept. 21,	657
Platt Co., The Frank S.	New Haven	Sept. 28,	671
Pomeroy, Edwin C.	Northville	Oct. 5,	691
Purinton, C. O.	Hartford	Dec. 13,	717
Raab, Joseph O.	Ansonia	Oct. 15,	705
Reck, Julius	Bridgeport	Nov. 12,	713
Roehrich, W. G.	Stratford	Sept. 29,	673
Saxe & Floto	Waterbury	Dec. 10,	716
Schleichert, F. C.	Bridgeport	Oct. 2,	687
Scott, J. W.	Hartford	Jan. 7, '16	721
Sierman, C. H.	Hartford	Sept. 27,	668
South Wilton Nurseries	South Wilton	Oct. 2,	683
Steck, Charles A.	Bethel	Oct. 7,	695
Stratfield Nursery Co.	Bridgeport	Oct. 20,	707
Turner & Co., Charles	Hartford	Oct. 18,	706
Vidbourne & Co., J.	Hartford	Sept. 27,	667
Woodruff, C. V.	Orange	Sept. 30,	678
Yale University Forest School ..	New Haven	Sept. 22,	660
Young, Mrs. Nellie A.	Pine Orchard	Oct. 13,	704

INSPECTION OF IMPORTED NURSERY STOCK.

On account of the war in Europe it was expected that there would be a marked decrease in the amount of European nursery stock shipped into Connecticut, but such was not the case. The fact that all species of pines from Europe are now prohibited from entering this country would also still further tend to reduce

the amount. It is true that the number of shipments (264) is less than that of last year (303) and the number of cases corresponding smaller (1,349 as against 1,477 last year). Nevertheless, the total number of plants inspected was considerably greater, amounting to 2,102,222 in comparison with 1,646,130 last year.

This inspection work has been done by the Entomologist and his assistants in coöperation with the Federal Horticultural Board at Washington, and three members of the staff are also collaborators of the Board. The Board issues permits for the stock to enter the United States and provides for a system of notices to be sent to the official in charge of the inspection work in each state to which shipments are consigned. The stock is then inspected on arrival at its destination by state inspectors. A report of each inspection is then sent to the Board at Washington and a duplicate report is kept on file in the office of the state inspector.

For the past year this inspection work has necessitated the equivalent of one man working 180 days of $7\frac{1}{2}$ hours each, or about three-fifths of the working time in an entire year. The cost, including salaries and travelling expenses, amounts to about \$1,100.00. As provided by the legislature, the expense of this work is defrayed from the appropriation for suppressing gipsy and brown-tail moths and for inspecting imported nursery stock.

The proportions of this stock from the various countries run about the same as last year (see Report of this Station for 1914, page 123), except that a slight increase may be noted from Belgium, and a slight decrease from Holland, England, Ireland and Germany. The source of this imported stock was as follows:

Country	No. Shipments	No. Cases
Holland	100	624
Belgium	100	471
France	30	206
England	14	23
Ireland	4	4
Germany	4	4
Scotland	6	8
Japan	3	6
Italy	1	1
Bermuda	1	1
Not given	1	1
Total	264	1349

In addition to the figures given above, notice was received of 12 shipments containing 25 cases. Of this stock, 8 cases were reshipped without inspection, 4 were refused, 2 were not received, 1 was inspected by a Federal inspector, and 10 contained herbaceous perennials, or greenhouse grown stock, which was not inspected.

Of the 264 shipments examined, 57 or 21.5 per cent. were found infested with insects or plant diseases, some of which are pests, as follows:

INFESTATIONS FOUND.

PLANT DISEASES.

Crown gall, *Bacterium tumifaciens* Smith & Towns. (7 shipments.)

On Manetti rose stock.

M. J. Gielen, Oudenbosch; Ebbinge & Van Groos, Wm. C. Hage & Co., Boskoop, Holland; Vincent Lebreton's Nursery, Angers, France; George Mount & Son, Canterbury; Kings Acre Nursery, Hereford; Walter Slocock, Woking, Surrey, England.

On *Philadelphus*. L. Renault, Orleans, France.

On *Ligustrum*. Louis Leroy, Angers, France.

On apple. Louis Leroy, Angers, France.

Hairy root on apple. Louis Leroy, Angers, France.

Fungus, *Exobasidium* on *Azalea indica*. (16 shipments.)

Van Dillewyn & Thiel, K. J. Kuyk, C. Petrick, Ghent; August Toeffaert, Destelbergen; De Bruycker & Drosbeke, Wynckel, St. Croix; Meirelbeke Nurseries, Meirelbeke; De Coster Bros., Bier & Ankersmit, Melle, Belgium; De Bruyne Bros., Loochristy, Belgium.

Pestalozzi guenini Desm. on Rhododendron. Barbier & Co., Orleans, France.

Ascomycete on Rhododendron. (2 shipments.)

Barbier & Co., Orleans, France.

C. Van Kleef & Co., Boskoop, Holland.

Rust, probably *Phragmidium subcorticium* (Schrank) Wint. on *Rosa rubiginosa*. L. Renault, Orleans, France.

INSECTS.

Aleyrodes sp. on *Azalea indica*.

Meirelbeke Nurseries, Meirelbeke, Belgium.

Scale on Bay trees. Aug. Toeffaert, Destelbergen, Belgium.

Scale, *Coccus hesperidum*, on Bay trees.

August Toeffaert, Destelbergen, Arthur De Meyer, Ghent, Belgium.

Oyster-shell scale, *Lepidosaphes ulmi* Linn. (9 shipments.)

On Boxwood, *Buxus*.

J. Blaauw & Co., W. Van Kleef & Sons, G. W. Van Gelderen, Schaum & Van Tol, Ebbinge & Van Groos, Boskoop (2); Verkade Van Kleef, Waddinxveen; Van Zonneveld Bros. & Phillipso (2), Sassenheim, Holland.

Diaspine Scale. On palm.

Arthur De Meyer, Ghent, Belgium.

Scale, *Saissetia nigra*, on Hibiscus.

Th. Outerbridge, Sunnylands, Bermuda.

Scale on Kentia.

La Soc. Anony. Hort. Ghent, Belgium.

Scale on palm.

Vander Sypt Freres, Loochristy, Belgium.

Galls on Oak. Louis Leroy, Angers, France.

Two Neuropteroids, Coccinellidae, Thysanura, on Bay trees.

Arthur De Meyer, Ghent, Belgium.

Dipterous larvae in soil with Rhododendrons.

Emile Vercauteren, Melle, Belgium.

Sawfly, *Emphytus cinctus* Linn., on Rose stock.

L. Renault, Orleans, France.

Borer (probably sawfly) on Manetti stock.

Franco-American Seedling Co. (A. Femand) (2), Angers, France.

Larvae of sawfly on Manetti stock.

Franco-American Seedling Co., Angers, France.

Larvae and pupae (Sawfly?) on Manetti stock.

Louis Leroy Nursery Company, Angers, France.

Lepidopterous larva on Bay trees.

August Toeffaert, Destelbergen, Belgium.

Lepidopterous pupa on Camperdown elm.

Louis Leroy, Angers, France.

Lepidopterous cocoon containing parasites, on *Azalea indica*.

K. Rosbergen & Son, Boskoop, Holland.

Lepidopterous cocoon (probably *Acronycta rumicis* Linn.) on Manetti rose stock. M. J. Gielen, Oudenbosch, Holland.

Lepidopterous pupa on *Azalea indica*.

De Coster Bros., Melle, Belgium.

Lepidopterous (?) eggs on bird's nest on Boxwood.

W. Van Kleef & Sons, Boskoop, Holland.

Pupa on *Azalea indica*. Van Dillewyn & Thiel, Ghent, Belgium.

Noctuid cocoon on *Azalea indica*. Van Dillewyn & Thiel, Ghent, Belgium.

Noctuid pupa on *Azalea indica*. Van Dillewyn & Thiel, Ghent, Belgium.

Tiger moth caterpillar on *Azalea indica*.

Arthur De Meyer, Ghent, Belgium.

Tussock moth eggs and cocoon case on Roses.

F. J. Grootendorst & Son, Boskoop, Holland.

Egg-mass (probably rusty tussock moth) on fruit stock.

Franco-American Seedling Co., Angers, France.

Work of red spider on *Araucaria*.

Vander Sypt Freres, Loochristy, Belgium.

Work of European Pine Shoot moth on *Pinus montana*.

C. Van Kleef & Co., Boskoop, Holland.

Cornus of grass. Franco-American Seedling Co., Angers, France.

INSPECTION OF APIARIES.

The number of apiaries as well as the number of colonies inspected in 1915 exceeds that of any preceding year, and it was done at a smaller average cost than ever before. As in former years, this work was done by Messrs. H. W. Coley of Westport, who has jurisdiction over Fairfield, New Haven, Middlesex and New London counties, and A. W. Yates of Hartford, who has the four northern counties of Litchfield, Hartford, Tolland and Windham.

Inspections were made in each county but of course not all apiaries were inspected or can be inspected in any one season. Neither was it possible to make inspections in every town in the state, though work was done in 1915 in 90 towns as against 77 towns in 1914.

There is in some cases an urgent demand each year from bee-keepers for this inspection. Hence it is necessary to go into certain towns each year, but it is part of our general plan, as we can now inspect without complaints, to cover all the towns of the state at least once in three or four years. Thus inspections were made in a number of towns in 1915 not visited in 1914, as may be seen by comparing the accompanying table with a similar one given on page 127 of the Report of this Station for 1914.

Hartford county leads the other counties in the number of apiaries inspected (190), while Fairfield county leads in the number of colonies examined (1,206).

A larger proportion of both apiaries and colonies were found to be free from disease than ever before. Most of the trouble was due to European Foul Brood, as has been the case in previous years. The only American Foul Brood found was in one apiary in New Canaan and in three apiaries in Old Lyme. The statistics of this apiary inspection are shown in the following table, which gives the number of apiaries and colonies inspected in each town where work was done, and in each county, as well as the number in each found diseased:

APIARIES INSPECTED, 1915.

Arranged by Counties and Towns.

Town	No. Apiaries			No. Colonies	
	Inspected	Diseased*	Quarantined	Inspected	Diseased
FAIRFIELD COUNTY.					
Bethel	4	2	1	29	9
Bridgeport	1	0	0	9	0
Danbury	4	2	0	33	5
Darien	1	0	0	20	0
Easton	3	1†	0	173	1†
Fairfield	11	3§	0	236	9||
New Canaan	6	4**	1	37	11††
Norwalk	3	0	0	30	0
Redding	5	0	0	35	0
Ridgefield	14	1	1	58	4
Stamford	11	4‡	2	87	9‡
Stratford	2	1	0	81	1
Trumbull	1	1†	0	72	3
Weston	2	0	0	7	0
Westport	8	2‡	0	91	2‡
Wilton	19	1	0	208	1
Total 16 towns ...	95	22	5	1206	55

NEW HAVEN COUNTY.

Beacon Falls	2	2	0	13	13
Cheshire	6	1	0	54	2
Derby	4	2	0	33	4
Hamden	3	2	0	37	2
Madison	1	1	0	28	5
Meriden	3	0	0	91	0
Middlebury	1	1	0	2	2
Milford	1	0	0	24	0
Naugatuck	3	0	0	20	0
New Haven	1	0	0	3	0
Seymour	3	0	0	27	0
Waterbury	4	1	1	75	8
Total 12 towns ...	32	10	1	407	36

MIDDLESEX COUNTY.

Chatham	4	2	1	83	29
Haddam	2	0	0	13	0
Killingworth	5	3§	0	37	7||
Middletown	1	1	0	3	2
Portland	2	0	0	28	0
Total 5 towns	14	6	1	164	38

Town	No. Apiaries			No. Colonies	
	Inspected	Diseased*	Quarantined	Inspected	Diseased
NEW LONDON COUNTY.					
Bozrah	2	1	1	8	3
Colchester	1	1	0	14	2
Griswold	1	1†	0	6	2†
Groton	1	0	0	6	0
Ledyard	4	0	0	36	0
Lisbon	3	2	0	12	5
Montville	10	9	4	51	36
New London	2	1	1	27	6
North Stonington	1	1	0	4	4
Norwich	7	3	0	143	81
Old Lyme	4	3§§	1	51	4††
Stonington	3	2†	0	41	2†
Waterford	4	2	2	72	16
Total 13 towns ...	43	26	9	471	161

LITCHFIELD COUNTY.

Barkhamsted	4	2	0	59	2
Bethlehem	5	1	0	30	1
Colebrook	1	1	0	7	7
Harwinton	1	0	0	1	0
Morris	2	0	0	6	0
New Hartford	2	2	0	19	3
Plymouth	6	4	0	34	14
Thomaston	11	5	0	40	6
Torrington	9	4	0	123	10
Watertown	7	3	1	55	4
Winchester	22	7	2	127	17
Total 11 towns ...	70	29	3	501	64

* European foul brood unless otherwise indicated.

† Sacbrood.

‡ One infested with sacbrood.

§ Two infested with sacbrood.

|| Three infested with sacbrood.

¶ Eight infested with sacbrood.

** One apiary has both American and European foul brood.

†† Seven colonies European, four American foul brood.

‡‡ Three colonies American, one both European and American foul brood.

§§ Two colonies American, one both European and American foul brood.

Town	No. Apiaries			No. Colonies	
	Inspected	Diseased	Quarantined	Inspected	Diseased
HARTFORD COUNTY.					
Berlin	16	1	0	75	1
Bloomfield	7	0	0	138	0
Bristol	6	2	0	34	4
Burlington	4	0	0	19	0
Canton	7	4	0	17	9
East Granby	5	2	0	29	4 _{and}
East Hartford	3	0	0	22	0
East Windsor	14	0	0	73	0
Enfield	9	1	0	24	3
Farmington	9	5	0	37	12
Glastonbury	17	2	0	69	4
Granby	7	0	0	77	0
Hartford	1	0	0	4	0
Hartland	4	3	2	18	6
Manchester	10	4	1	23	5
New Britain	15	1	0	101	1
Newington	4	0	0	57	0
Plainville	7	2	0	35	5
Rocky Hill	5	1	0	17	0
South Windsor	5	1	0	31	1
West Hartford	11	1	0	80	0
Wethersfield	10	1	0	57	4
Windsor	9	0	0	48	0
Windsor Locks	5	1	1	48	2
Total 24 towns ...	190	32	4	1,133	61
TOLLAND COUNTY.					
Andover	2	1	0	54	1
Bolton	2	0	0	9	0
Coventry	5	1	1	20	4
Ellington	4	0	0	23	0
Vernon	11	0	0	93	0
Total 5 towns	24	2	1	199	5
WINDHAM COUNTY.					
Killingly	4	2	0	28	4
Pomfret	12	6	1	52	18
Putnam	7	5	0	29	10
Woodstock	3	3	1	51	17
Total 4 towns	26	16	2	160	49
Grand total 90 towns..	494	143	26	4,241	469

SUMMARY OF APIARY INSPECTION.

County	No. Towns	No. Apiaries		No. Colonies	
		Inspected	Diseased	Inspected	Diseased
Fairfield	16	95	22	1,206	55
New Haven	12	32	10	407	36
Middlesex	5	14	6	164	38
New London	13	43	26	471	161
Litchfield	11	70	29	501	64
Hartford	24	190	32	1,133	61
Tolland	5	24	2	199	5
Windham	4	26	16	160	49
Total	90	494	143	4,241	469

	Apiaries	Colonies
Number inspected	494	4,241
Infested European foul brood	129	441
Per cent. infested	26.1	10.3
Infested American foul brood	4	8
Per cent. infested	.8	.18
Pickled or sacbrood	10	20
Average number of colonies per apiary		8.58
Cost of inspection		\$746.31
Average cost per apiary		1.51
Average cost per colony		.175

GIPSY MOTH SUPPRESSION WORK IN 1915. ✓

By W. E. BRITTON AND IRVING W. DAVIS.

WINTER SCOUTING.

Scouting for gipsy moth egg-clusters in Connecticut during the winter of 1913-14 by Federal men resulted in finding ten towns infested with this pest. (See Report for 1914, page 133.) This winter, therefore, these ten towns, together with those bordering them on the west, were searched, also by Federal men, and ten additional towns were found infested; namely, Eastford, Chaplin, Hampton, Scotland, Canterbury, Plainfield, Sterling, Sprague, Lisbon and Griswold. These towns are all shown east of the quarantine line of the map in figure 1 on page 100.

The State kept one crew in the field this past winter, which, besides working in Stonington and North Stonington, scouted the old infested area at Wallingford. This crew consisted of five men,—Messrs. Zappe and Davis of the Station staff, and C. W. Bolton, H. B. Bursley and J. S. Shepard.

The method employed in this scouting was to examine carefully all the trees along each roadside, paying particular attention to fruit trees and oaks, which are the favorite food plants of the gipsy moth. All trees around the houses were examined, as well as old apple orchards and scrub apple trees, many of the latter being a mile or more back from the highway. The pasture oaks and other scattering trees in the fields were scouted,

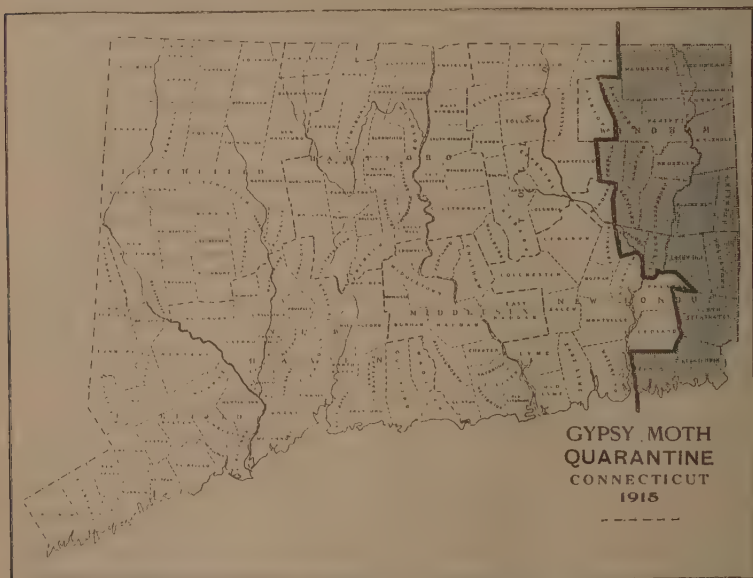


FIG. 1. Map of Connecticut showing towns infested by the Gipsy Moth, and quarantined in 1915.

while in the woodland along each highway a strip varying from 50 to 100 feet in width was worked.

No egg-clusters and only one pupa case were found. The pupa case, a female, was taken in the northern part of the town of Stonington near the *Anquilla* infestations of a year ago. Around this section every effort was made to locate further traces of the pest but none were found.

In Wallingford, the scouting was essentially the same as a year ago. The section which had been burlapped during the previous summer was scouted and no egg-clusters were found. We now believe that the Wallingford colony has been exterminated.

SUMMER WORK.

For the past two years the Federal Government has done the most of the scouting work in Connecticut as the limited funds permitted the State to work only two or three towns.

The Legislature this year granted an increased appropriation for this work which became available about the 20th of May, and soon after this date the entire area infested was taken over by the State.

Federal men had by that time worked nearly two weeks. At all of the infestations tanglefoot had been applied to the trees and the infestations were being patrolled regularly by the Government men.

Mr. L. H. Worthley, who is in charge of the Federal scouts, very kindly offered their services for the remainder of the summer work. This offer was readily accepted and the men were placed upon the State pay roll for a few weeks.

The first part of June a power sprayer was purchased, and 62 infestations in the worst infested towns were sprayed. Although this work was done rather late for the best results, the outfit will be available another year as soon as the season opens.

The work closed on July 24, but the most serious infestations, which are in the northeastern corner of the State (Thompson, Woodstock and Putnam), were watched until after the first of August.

Thompson—166 Infestations.

Many more infestations were found in the town of Thompson than in any other infested town in this State, but this may be partly accounted for by the fact that the entire area of the town was scouted during the summer of 1914. This naturally divided the infestations into two classes, i. e., the woodland and the roadside, the former numbering 73 and the latter 93.

Some of the infestations in Thompson are among the most serious in the State, and though 70 of them showed larvae, in most cases it was for a short period only and they were not abundant.

During June the sprayer was taken into Thompson, and 28 of the worst infestations in the town were sprayed.

The work of examining the tanglefoot bands commenced about the middle of May and continued until the seventh of August. The town will be scouted this coming winter and vigorous methods will be taken to exterminate this pest.

Woodstock—40 Infestations.

This town is a rather large one and contains a great many apple orchards and white oak trees, which are among the favorite food plants of the gipsy caterpillars, and during last winter 40 infestations were found here.

The majority of the egg-clusters were in a line running from the northeast to the southwest, while in the other sections the infestations were scattering.

There were a large number of infestations near the village of East Woodstock, but of the 40 in the entire town, only 13 showed larvae and 12 of these were sprayed.

During the latter part of the summer work, two new infestations were located, one a little out from East Woodstock, and the other in a swamp near the south part of the town.

At the former infestation a large apple tree was taken down and four egg-clusters found, while on that and neighboring trees 338 caterpillars were killed. In the later visits to this infestation none of the pests were found.

The last infestation was found on the 29th of July, and from then on until August 7th 100 larvae were taken.

Putnam—24 Infestations.

The twenty-four infestations in this town made Putnam one of the most thickly infested towns in the State, due to the fact that Putnam, as regards area, is one of the smaller towns in that section of Connecticut.

Larvae were found at twelve of these infestations, and eleven of them were sprayed. Three infestations, one in the city itself, and two on a cross-road a few miles east of the city, were by far the worst infestations within the town boundaries. At these three places were taken approximately five-sixths of the larvae found in Putnam. Few, however, were taken after the first of July.

On the seventeenth of July several caterpillars were discovered outside of the banded district at an infestation on Putnam

Heights. Extra work was done there, and during the last few visits nothing was found.

Pomfret—22 Infestations.

The twenty-two infestations in Pomfret were well distributed throughout the town. Only three showed larvae to any extent and these only a few as compared with infestations in other towns. Two of these infestations were near the village of Abington in the south part of the town, while the one furnishing the most larvae was north of Pomfret Street on the road leading to Woodstock.

The sprayer was used at two of these infestations and they were all patrolled until the first of August.

Eastford—4 Infestations.

This was one of the westernmost towns infested and contained four separate infestations which, with one exception, were on roads leading from the Eastford Post-office to the Pomfret line. The fourth infestation was a pupa case on the road from Phoenixville to Ashford.

At two of the infestations in the north part of the town a few larvae were taken. Both of these infestations were sprayed in June and were patrolled until the last of July, the larvae taken during that time numbering eight for both infestations.

Killingly—15 Infestations.

The northern portion, near the Putnam line, was the worst infested section of Killingly, eight of the fifteen infestations being located there.

At the beginning of the season several larvae were taken at two infestations on the State road leading from Danielson to Putnam and these were sprayed early in June.

Toward the end of June, at one of the two infestations in the village of Danielson, a marked increase in the number of larvae was noted. The trees near by were thoroughly sprayed and thereafter only a few scattering larvae were seen, the last being taken on July 24th.

Of the other infestations, five showed larvae in the early part of the season but none were found after the first of July so were not considered as serious.

Brooklyn—2 Infestations.

Only two infestations were found in Brooklyn, one of seven, and the other of eight egg-clusters. These were both some distance from orchards or oak woods. Larvae of the gipsy moths were found at both until well into July.

Hampton—8 Infestations.

Eight gipsy moth infestations were found in the town of Hampton during the past winter's scouting. While these were scattered throughout the town, none of them appeared to be very serious. Larvae were found at seven of the eight infestations and during June three of the worst were sprayed. There were no larvae taken after the middle of July although the work did not close until the first of August.

Chaplin—1 Infestation.

The result of scouting this town was the finding of one infestation of seven egg-clusters. This was visited numerous times during the summer but no larvae were found.

Sterling—2 Infestations.

There were two infestations in this town, one near the central part of the town, north of Sterling Station, and the other in the south part near the Rhode Island line.

Both of these infestations showed larvae. At the former ten were found, the last one being taken on the 13th of July.

At the southern infestation 813 larvae were found. Early in June, 15 egg-clusters were located in some rocks about four rods from the infested tree. The brush was cut and burned and the remaining foliage sprayed. Scattering larvae were taken until the 28th of July, but from then until the work closed nothing more was found.

Plainfield—1 Infestation.

A single egg-cluster was found in this town as the result of the winter's scouting, but no larvae were taken here during the summer.

Canterbury—6 Infestations.

Six widely separated infestations were found in this town, but there were only two at which larvae were taken, one in the south

part of the town near the Griswold line, and the other in the very northern part near the Hampton line.

At the latter three larvae were taken on the first visit, but after that nothing was found.

The infestation near the southern boundary of the town was located in a roadside white oak. A total of 13 larvae were taken at this infestation previous to July 6th and none later, though many visits were made.

Scotland—I Infestation.

The single infestation in this town contained twenty-six egg-clusters. This, like the other infestations throughout the State, was watched during the caterpillar season and twenty-six larvae were taken.

Voluntown—I Infestation.

Only one infestation was located in this town and that a pupa case. No larvae were found here during the summer.

Griswold—4 Infestations.

Of the four infestations in this town, two were in the southern portion and two in the northern portion of the town.

In the south part, both infestations consisted of pupa cases and no larvae were found.

The northern infestations contained respectively ten and thirty egg-clusters. At the former several larvae were taken during May, but none thereafter. The latter, however, appeared rather serious at first and extra work was done during June. The number of larvae steadily diminished until no more larvae were found, although four visits were made to this infestation after the last larva was taken.

Lisbon—3 Infestations.

These three infestations were widely separated and the only one at which larvae were taken was near the center of the town on the road from Versailles to Newent. Five larvae were discovered here early in June, and from then until the work closed the last of July nothing more was found.

Sprague—2 Infestations.

The visits to the two infestations in this town were made at various times during the summer, but no larvae were found.

North Stonington—1 Infestation.

The winter scouting of this town resulted in finding only one egg-cluster. This was located near Spalding Pond and although visited several times this summer, no larvae were found.

Stonington.

This town contained the original gipsy moth infestation in this State, which was found near the borough of Stonington in 1906. From that time until 1913 control measures were practiced and the colony exterminated (see former reports for full account of the work). The windspread of 1913 resulted in seven infestations being found in Stonington but during this last year no egg-clusters were located. During the past summer the old infestations were examined occasionally and nothing found.

Groton—4 Infestations.

At Groton the infestations were all on the easterly side of Pearl St., in the village of Mystic.

The work was started here early in May and several trees were sprayed, tin patches put on, and some general pruning done.

The infestations were inspected on the average of four times a week during the caterpillar season. During the latter part of May and first part of June, several caterpillars were found, but during the rest of the season no larvae were taken.

Altogether, therefore, 20 towns were found infested in 308 separate localities, due, it is now believed, to windspread soon after the hatching season of 1913, though some of the infestations were only recently discovered. In all, about 6,000 tangle-foot bands were applied, and 62 infestations were sprayed. In six towns no caterpillars were found and possibly these towns are no longer infested, though considerable additional work must be done in them to make sure.

The following table shows the statistics of this work for the year:

SUMMARY OF GIPSY MOTH WORK

	No. of Infesta- tions	No. with larvae	No. Sprayed	Total No. of larvae	Work closed
Thompson	166	70	27	2,132	Aug. 7
Putnam	24	12	11	1,442	July 31
Woodstock	40	13	12	2,163	Aug. 7
Pomfret	22	10	2	208	July 31
Brooklyn	2	2	0	56	" "
Scotland	1	1	0	26	" "
Killingly	15	8	3	358	" "
Eastford	4	2	2	8	" "
Canterbury	6	2	0	16	" "
Sterling	2	2	1	823	" "
Hampton	8	8	3	269	" "
Plainfield	1	0	0	0	" "
Lisbon	3	1	0	5	" "
Voluntown	1	0	0	0	" "
Sprague	2	0	0	0	" "
Griswold	4	2	0	161	" "
North Stonington	1	0	0	0	" "
Stonington	1	0	0	0	" "
Groton	4	1	1	147	" "
Chaplin	1	0	0	0	" "
Totals:					
20 towns infested	308	134	62	7,814	

NEW EQUIPMENT.

To enable us to properly supervise the work in the several towns, a Ford touring car was purchased. This arrived early in June and has been in constant use since. With this car Mr. Davis can visit each infestation frequently and keep in touch with the work of all of the men. He can also use it to advantage in transporting men from one town to another and for carrying small tools and supplies from one point to another.

An Indian motor cycle was purchased in May for one of the men to use in going from one infestation to another. This enables one man to visit several places in one day, even though five or ten miles apart, and is about the only way of handling small and isolated infestations distant from steam and electric railroads.

As some of the worst infestations were in woodlands and needed spraying, and the Federal organization did not have a sufficient number of power sprayers to supply Connecticut and attend to the other infestations, it seemed best for the State to

purchase an outfit for use within its borders. A Fitzhenry-Guptill power sprayer was therefore purchased, together with 1,500 feet of pressure hose, 100 feet of suction hose and two Worthley nozzles. This outfit (shown on plate IV, b), was found to be most efficient and with it 62 of the most dangerous infestations were sprayed with arsenate of lead.

LEGISLATION.

As regards suppressive work against the gipsy and brown-tail moths, the 1915 session of the General Assembly was an important one. Two measures were introduced, one asking for an appropriation of \$30,000.00 to enable the State Entomologist to cope with the situation. After the usual hearings and conferences, the legislature in due season granted a total of \$25,000.00 for the purpose, but divided it into two separate items—one of \$21,000.00 for the two fiscal years ending September 30, 1917,—and one of \$4,000.00 as a deficiency measure taking effect upon its passage (May 18th) and becoming immediately available for summer work. As will be seen from the financial statement on page 82, this money in addition to that previously appropriated was all expended.

The other important measure was a new bill, making provision for towns to carry on suppressive measures against these insects under the direction of, and when requested to do so by, the State Entomologist. The new law is given below:

CHAPTER 267, PUBLIC ACTS OF 1915.

AN ACT CONCERNING THE SUPPRESSION OF GIPSY MOTHS AND BROWN TAIL MOTHS.

SECTION 1. The selectmen of any town, the warden of any consolidated town and borough, or the mayor of any consolidated town and city, upon request of the state entomologist and with his concurrence, shall appoint an agent in such town who shall perform the duties required by the provisions of this act and such duties as may be prescribed by the rules and instructions of the state entomologist approved as herein provided. Upon the failure of such selectmen, warden, or mayor to make such appointment within fifteen days from the receipt of notice from the state entomologist of the existence of gipsy moths or brown tail moths in such town, the state entomologist may appoint an agent therein and fix his compensation.

SEC. 2. Each agent appointed pursuant to the provisions of section one, on ascertaining the presence of such moths in any stage of develop-

ment in the town wherein he is appointed to act as such agent, shall forthwith investigate the extent of the area infested and report to the selectmen, warden, or mayor, as the case may be, or to the state entomologist, and any agent of a town adjacent to the town wherein he is serving as such agent. The state entomologist, subject to the approval of the board of control of the Connecticut agricultural experiment station, shall issue such orders, rules, and instructions concerning the suppression of said moths as he may deem advisable, and copies thereof shall be sent by him to the agents in the several towns and to the selectmen thereof, wardens of boroughs, mayors of cities, and such other state and local officials as he may consider advisable. In the performance of the duties prescribed by this act and such duties as may be imposed by the rules and regulations of the state entomologist, the agents shall be under the direction of the state entomologist, or such assistants or deputies as may be appointed by the board of control of the Connecticut agricultural experiment station.

SEC. 3. The state entomologist shall receive no additional compensation for services performed under the provisions of this act. The salaries of the assistants or deputies appointed by the board of control of the Connecticut agricultural experiment station shall be fixed by said board and, with the expenses of the state entomologist and of such assistants or deputies, shall be paid by the comptroller in monthly installments, upon vouchers approved by the state entomologist. The state entomologist, subject to the approval of said board, may procure such equipment, apparatus, and supplies, as may be necessary for the performance of his duties under the provisions of this act, upon vouchers approved by the state entomologist, and the cost thereof shall be paid by the treasurer upon order of the comptroller. Each agent shall receive compensation to be fixed by the selectmen of the town, the warden of the borough, or the mayor of the city, subject to the approval of the state entomologist, which compensation shall not exceed three dollars per day while engaged in the extermination or suppression of such moths. Any person employed by such agent to assist in such work shall, on approval of the state entomologist, receive such compensation from the town as may be determined by the selectmen, the warden, or mayor, as the case may be. Such agent shall render to the selectmen a statement of the services rendered by him and his employees and of his and their necessary expenses on the first day of each month for the month preceding. Such statement shall show in detail the amount and character of the services performed, the duration thereof, and the disbursements, charges, and expenses incurred by him during such period. A copy of such statement shall be forwarded to the state entomologist and, when approved by him, the selectmen of the town wherein such services were rendered and expenses incurred, or the warden or mayor, as the case may be, shall draw an order on the treasurer of such municipality for the amount thereof. The supplies used in any town by the state entomologist, his deputy or assistant, or by any town agent shall be furnished by the state. All accounts which have been paid by any municipality

within thirty days of the approval thereof by the state entomologist, shall be certified by the treasurer of such municipality to the comptroller during the first ten days of January, April, July, and October in each year, and one-half the amount thereof expended during the quarter next preceding shall be paid by the state, and the comptroller shall draw his order on the treasurer in favor of the treasurer of such municipality for such amount, provided the amount which the state may expend in any year, including the compensation of the assistants or deputies and other expenses, and the expenses of the state entomologist, with the cost of apparatus and equipment, shall not exceed the sum appropriated for the suppression of the gipsy and brown tail moth for any year, and provided the portion of the expense for which any municipality shall be liable in any year under the provisions of this act shall not exceed seven hundred and fifty dollars.

SEC. 4. Any person who shall hinder or obstruct the state entomologist, his assistant, deputy, or any agent appointed under the provisions of this act, or any other person employed by him, while engaged in the suppression of such moths, shall be fined not less than five nor more than fifty dollars. No action for trespass shall lie against any person authorized under the provisions of this act, or against any duly authorized agent of the United States department of agriculture, for necessary damage done while engaged in the performance of his duties in suppressing such moths.

SEC. 5. The state entomologist shall report to each regular session of the general assembly, during the first week thereof, his doings and expenses incurred under the provisions of this act, with such recommendations as he may deem advisable.

Approved, May 18, 1915.

As the old law gave the State Entomologist authority to do certain things, and also provided a heavy penalty for transporting living gipsy or brown-tail moths in any of their stages, it was thought best to let this law stand, rather than to repeal it and include its provisions in the new law. This old law is as follows:

CHAPTER 114, PUBLIC ACTS OF 1907.

AN ACT CONCERNING GIPSY AND BROWN-TAIL MOTHS.

SECTION 1. The insect commonly known as the gipsy moth and the brown-tail moth, being serious pests of vegetation, are, in all stages of their development, hereby declared to be a public nuisance.

SEC. 2. The state entomologist shall have authority to suppress and exterminate said gipsy and brown-tail moths, and may employ such assistants and laborers as he deems expedient; may cut and burn brush and worthless trees in fields, pastures, or woodlands, or along the roadsides on any public or private grounds; and may prune, spray, scrape, or fill cavities in any fruit, shade, or forest trees, or clean up any rubbish for the purpose of furthering said work. The said state entomologist,

or any of his assistants, deputies, agents, or employes, shall have the right, at all times, to enter any public or private grounds in the performance of their duties.

SEC. 3. Any person transporting living eggs, larvae, pupae, or adults of the gipsy or brown-tail moths into the state, or from an infested region within the state to a region not hitherto infested, shall be fined not more than one thousand dollars or imprisoned not more than one year.

SEC. 4. Any person wilfully obstructing or hindering said state entomologist or his assistants or employes, in the work of suppressing said insects, shall be fined not less than twenty-five nor more than five hundred dollars.

Approved, June 5, 1907.

BROWN-TAIL MOTH WORK, SEASON OF 1914-15.

By W. E. BRITTON AND IRVING W. DAVIS.

The gipsy moth having spread into the eastern end of Connecticut during the early summer of 1913, it seemed advisable to use our limited available funds in checking this pest rather than to spend any considerable portion of the money in scouting for the brown-tail moth which now infests about one-half of the State. For this reason there was less scouting for brown-tail moth nests than in any previous winter since the State became infested. This scouting, which was done by Messrs. J. H. Osgood and E. R. Sherman, consisted of working the row of towns just west of the present quarantine line to determine the spread of the moths during the year and in collecting nests in various towns already infested, to ascertain the presence of introduced parasites. This latter work was under the direction of the Federal Government.

Since the object of this scouting was merely to determine the spread of the brown-tail moth beyond the present quarantined area, each town bordering this line on the west was scouted and if no nests were found the entire town was covered; when nests were taken, showing that town to be infested, the scouts immediately proceeded to the next town west. Seventeen towns were thus visited and only three towns found infested for the first time; namely, Wethersfield, Newington and New Britain. These three towns are near together in the central part of the State, and just south of Hartford and West Hartford, which have been infested for at least two years.

The following eight towns were scouted and brown-tail nests were cut for the purpose of recovering parasites:—Stonington, Lyme, Norwich, Lebanon, Chatham, Mansfield, Hartford and Suffield. In none of these towns were the moths found in large numbers, about 100 nests being taken in the eastern part of Stonington, 28 in Suffield, 12 each in Hartford and Norwich, while 10 were cut in Lebanon. In the three remaining towns, Lyme, Mansfield and Chatham, nothing was found. The finding of only 12 nests in Hartford is a notable feature, for it shows a marked decrease since two years ago when 747 nests were taken in that city.

Aside from this, reports have been received in regard to the prevalence of brown-tail moths in various towns within the district already infested, which indicate that the northeastern corner of the State, including the towns of Thompson, Woodstock, Putnam and Pomfret, are the most thickly infested at the present time. But even here the nests were not very abundant anywhere, and apparently less so than in 1912-1913 and 1913-1914. Nearly all nests were small and scattered and in many of them the larvae were dead. This may be due in part to climatic conditions, as there was a heavy frost in September, while the caterpillars were making their nests. It may also be in part due to parasites.

As only three new towns,—Wethersfield, Newington and New Britain,—were found infested, it hardly seems worth while to publish herein a map of the state showing the area infested by this insect, and the reader is referred to the map in last year's report (1914), page 135.

INTRODUCED NATURAL ENEMIES.

Mention has been made at various times in this and preceding reports and bulletins that certain parasites of the gipsy and brown-tail moths had been introduced into this country, and that some of them had been colonized in Connecticut. Some of these attack both gipsy moths and brown-tail moths. Some have been colonized in Connecticut, while others have spread into the State from Rhode Island and Massachusetts.

For the following records we are indebted to Mr. A. F. Burgess, who is in charge of the moth work for the Federal Bureau of Entomology. Most of the recoveries have been made from brown-tail nests.

Apanteles lacteicolor Viereck, a small hymenopterous or four-winged fly parasitic on brown-tail caterpillars, was colonized in 1912 at Putnam; in 1913 at Killingly, Hampton, Plainfield, Griswold, Norwich, Stonington, Mansfield, Suffield and Hartford; in 1915, at Lebanon, Chester and Manchester. Recovered in 1913 from Thompson, Woodstock, Pomfret, Stafford and Somers; in 1914, from Hartford and Waterford; in 1915, from Suffield and Stonington.

Pteromalus egregius Foerster, a minute four-winged fly parasitic on brown-tail caterpillars, not colonized, but recovered from Hartford in 1913 and in 1915.

Monodontomerus areus Walker, a minute four-winged fly parasitic on the pupae of both gipsy and brown-tail moths. Not colonized, but recovered from Putnam in 1911, and from Suffield and Hartford in 1913.

Meteorus versicolor Wesm., a minute four-winged fly parasitic on brown-tail caterpillars. No attempted colonization, but cocoons were probably mixed with those of *Apanteles lacteicolor*. Recovered from Hartford in 1914.

Compsilura concinnata Meigen, a medium-sized two-winged fly parasitic on the caterpillars of both the gipsy and the brown-tail moths. Colonized at Putnam in 1912; at Hartford, 1913; at Mansfield, Plainfield and Stonington in 1914, and at Stafford, Suffield, Colchester, Norwich and Old Lyme in 1915. Recovered from Woodstock in 1913.

Calosoma sycophanta Linn. A large predaceous ground beetle which in both its larval and adult stages feeds upon gipsy caterpillars. A colony was planted at Stonington in 1914. Recovered in 1914 from Thompson, whence it had probably spread from Massachusetts or Rhode Island. On May 24, 1915 an adult of this species was taken at light by Mr. Harry L. Johnson, at Meriden, at least 40 miles from the nearest known point where a colony had been liberated.

It seems, therefore, that these natural enemies of the gipsy moth and the brown-tail moth are well established in Connecticut and may be counted upon to aid in holding these pests in check. It will be many years, however, before they can become sufficiently abundant to control these pests absolutely, and perhaps that time may never come. Artificial control measures must be practiced, in order to reduce to the minimum the areas infested.

FUTURE MOTH WORK.

The new law, printed on page 108 of this report, provides that towns carry on suppression work against both the gipsy and brown-tail moths, when instructed to do so by the State Entomologist, and under his direction. Effective work against the gipsy moth can be done only by men who have had experience and careful training, and it would be difficult to find such men who could be appointed as town agents to do this work. Consequently we deem it advisable, at least for the present, to leave the gipsy moth work entirely in the hands of trained men employed directly by the State Entomologist and by the Federal Bureau of Entomology.

On the other hand, certain towns will be asked to cut off the brown-tail moth nests, especially where the insect is abundant and threatens to become a great nuisance, or where there is particular danger of its spreading to new territory.

These plans, however, are subject to change and revision whenever conditions warrant it.

EXPERIMENTS IN CONTROLLING THE CABBAGE
MAGGOT IN 1915.

By W. E. BRITTON AND QUINCY S. LOWRY.

One of the most important insect pests of early cabbages in Connecticut is the cabbage root maggot, *Phorbia brassicae* Bouché, which was described in the Report of this Station for 1914, page 142, and on page 152 of the same Report is given an account of the experiments in controlling this insect in 1914.

In 1915, the maggots were very abundant and did more damage than usual; consequently the season was particularly favorable for control experiments. The warm weather of the latter part of April caused the adult flies to appear unusually early and the first eggs were found April 28th.

EXPERIMENTS AT STATION FARM.

For the purposes of this experiment there was assigned a small field having an area of about half an acre, at the Station farm at Mt. Carmel, its greatest dimension, and consequently the rows, extending nearly north and south. On this land soy beans had been grown in 1914, and before setting the plants, the ground was thoroughly plowed, harrowed, and enriched by an applica-

tion of about 800 lbs. of a complete home-mixed chemical fertilizer. No stable manure was applied. This field is shown on plate VI, a.

The plants used were purchased from A. N. Farnham of New Haven. The seed was sown February 22d, and the young plants transplanted into cold frames March 16th. On April 16th, they were set in the field, in 16 rows and about 18 inches apart in the row. The varieties were Early Jersey Wakefield 5 rows, Copenhagen Market 5 rows, Succession 5 rows, and one row of Market Gardener's No. 2. Each variety filled the entire space in the rows, which were about 550 feet long and contained 362 plants per row, and a total of about 5,800 plants.

The field was divided crosswise into twelve equal sections, each containing 480 plants, the varieties mentioned being proportioned the same in each section. As the south end was considerably higher than the north end, treatment was duplicated in order to act as a check on the final results. Hot and dry weather followed the setting of the plants, and some of them were watered several times. Nevertheless, a number of plants died and were replaced a few days later with plants of the same varieties.

The first maggots were found on May 18th, and as might be expected were most abundant on the lower or north end of the field. The sections were numbered beginning at the north end and were given treatment as follows:

Sec.	Treatment	Sec.	Treatment
1.	Tarred paper disks.	7.	} Poisoned bait to kill adults.
2.	Check (no treatment).	8.	
3.	Crude carbolic acid emulsion.	9.	Sludge (Lime-sulphur).
4.	Naphthaline (moth balls).	10.	Crude carbolic acid emulsion.
5.	Corrosive sublimate.	11.	Check (no treatment).
6.	Sludge (Lime-sulphur).	12.	Tarred paper disks.

As these were all early varieties, the damage caused by the maggot was apparent in May and early in June. A careful examination of all plants was made June 18th and the results are included in the following descriptions of the various treatments:

Sections 1 and 12. Tarred Paper Disks.

The hexagonal disks, described in the Report of this Station for 1914, page 147, were used in this experiment and were applied shortly after the plants were set in the field. Though many eggs were laid on, under and around these disks, a comparatively small

number of plants were damaged by the maggots. As has already been stated, maggots were more abundant in Section 1 at the lower end of the field than on Section 12 at the upper end, a total of 24 plants in Section 1, and 19 plants in Section 12, or an average loss of 4.4 per cent. were killed by maggots. This was the most effective of any treatment tested in this experiment, as the table on page 117 will show.

Sections 2 and 11. Check (No Treatment).

In Section 2, 157 plants were killed as against 24 plants in Section 1 adjoining. The difference is well shown on plate VI, b, photographed on June 18th. In Section 11, 67 plants were killed by maggots, making a total average loss of 23.3 per cent. where no treatment was given.

Sections 3 and 10. Crude Carbolic Acid Emulsion.

The second best results were obtained from the use of crude carbolic acid emulsion prepared after the following formula:

Hard soap, 1 lb., or soft soap, 1 qt.
Boiling water, 1 gal.
Crude carbolic acid, 1 pt.

Dissolve the soap in the boiling water, add the acid and churn as in making kerosene emulsion. This mixture thickens on cooling, and should be diluted with 30 times its bulk of water before using.

Two applications were given to the plants, April 28th and May 27th, about three fluid ounces being poured from a ladle into a depression around the stem of each plant. The loss resulting from the attack of the maggots was 31 in Section 3, and 27 in Section 10, an average loss of 6 per cent.

Section 4. Naphthaline (Moth Balls).

Naphthaline was tried again this year, one moth ball being placed about $1\frac{1}{2}$ inches from the stem of each plant, directly after setting. A loss of 17.5 per cent. was obtained in this section, which was not duplicated.

Section 5. Corrosive Sublimate or Mercuric Chloride.

Corrosive sublimate, being recommended by market gardeners to kill maggots, was given a trial in Section 5. It should be applied as soon as the first maggots appear.

Formula used:—4 ounces corrosive sublimate to 55 gallons of water. This section was treated May 19th and again May 27th,

about one teacupful of the solution being applied around the stem of each plant. A loss of 14.7 per cent. was the result. The treatment was not duplicated elsewhere.

Sections 6 and 9. Lime Sulphur Sludge.

This material is a waste product from the manufacture of commercial lime-sulphur and was tried last year with results which seemed to warrant further tests. It is diluted with water and applied in the form of a paste, which with the soil hardens on drying, forming a disk similar to the tarred disks, about four inches in diameter. This treatment proved itself the third best treatment tried last year and ranks the same again this year.

The sludge was diluted five times its bulk with water, about three fluid ounces being applied to each plant. One application was made on April 26th. The resulting loss was 69 plants in Section 6, and 35 plants in Section 9, or a total average loss of 10.8 per cent.

Sections 7 and 8. Poisoned Bait (Adult Treatment).

This poison in a sweetened mixture and sprayed upon the leaves has been found an effective method of controlling the onion maggot in Wisconsin by Professor J. G. Sanders. Consequently it was given a trial against the cabbage maggot in Sections 7 and 8. It should be sprayed upon the foliage of the plants as soon as possible after setting, in order that the flies may feed on this sweetened poisoned spray and be killed before laying eggs. The following formula was used:

1 gram sodium arsenite
1 gallon water
 $\frac{1}{4}$ pint molasses.

The result was an average loss of 15.8 per cent. by maggots. No injury was caused to the foliage by the spray.

Summary of Results Obtained in 1915.

Treatment	No. Plants	No. Infested	Per cent. Infested
Tarred Paper Disks	960	43	4.4
Crude Carbolic Acid Emulsion	960	58	6.0
Lime Sulphur Sludge	960	104	10.8
Corrosive Sublimate	480	71	14.7
Poisoned Bait	960	152	15.8
Naphthaline Balls	480	80	17.5
Check	960	224	23.3

EXPERIMENTS AT MR. A. N. FARNHAM'S.

On May 10th a complaint was made by Mr. Farnham that there were a great many cabbage maggot flies laying eggs on and underneath the tarred paper disks which had been applied to his entire field of cabbages. The field was examined and found to be quite badly infested. Eggs were found under the disks, due to the fact that most of the disks were not properly applied. The disks were removed from the field, and on 12 rows, each row containing 50 plants, crude carbolic acid emulsion was applied around the stems of the plants.

On May 20th the field was examined. At a glance one could tell just where the treated section was located in the field. Out of the 600 plants treated only two were badly wilted due to the attack of the maggot, while on either side of the treated section there was a loss, in some rows of one-third, by maggot injury. A second application was given May 24th. On June 21st a final count was taken. There was a loss of 24 plants or 4 per cent. in the crude carbolic acid emulsion section and 120 plants or 20 per cent. killed in the check section adjoining.

A DESTRUCTIVE EUROPEAN PINE SAWFLY
IN CONNECTICUT.*Diprion (Lophyrus) simile* Hartig.

While inspecting a nursery in New Haven, August 1914, with my assistants, Mr. I. W. Davis and Mr. M. P. Zappe, we noticed some sawfly larvae feeding upon pine trees. The work continued for several days and in another part of the nursery these larvae were even more abundant. We gathered all that could be found, and where they were thickest all hands spent an hour or more collecting them. All of this material was taken to the laboratory.

Prior to this time Dr. Alexander D. MacGillivray had prepared the manuscript on sawflies for the Hymenoptera of Connecticut, which is now in press; he has also made a study of sawfly larvae, and has requested that material be sent him. Supposing this sawfly to be a native species, though unfamiliar to us, we sent a portion of this material to Dr. MacGillivray, and placed the remainder in our breeding cages for the purpose of rearing the adults. Dr. MacGillivray was unable to identify the

species from the larvae but thought that he might recognize it in the adult stage.

A male emerged from the cocoons in the cages, April 8, 1915, followed by others, and on April 15 the first female was obtained. Living specimens of both sexes were placed in cages containing potted white pines, and the females soon laid eggs.

I wrote a letter to Dr. MacGillivray April 21, informing him of the emergence of the adults. He looked in his own cages and found that the adults had emerged there also. He replied that he did not recognize the species but that it belonged to the genus *Diprion*, formerly known as *Lophyrus*; that the species are badly confused; and that Mr. S. A. Rohwer of the Bureau of Entomology at Washington was trying to straighten them out and had already examined many of the types in the British Museum. He suggested that material should be sent to Mr. Rohwer. This was done on May 6, and Mr. Rohwer soon replied as follows:

I have determined this species, tentatively, as *Diprion simile* Hartig. The adults agree more closely with those in the collection under the name *pini* but the larvæ answer exactly the description of *simile*, and as these two species are very closely allied and easily confused in the adults I have made the determination from the larvæ rather than from the adults.

This species is one of the most injurious sawflies on European conifers and has been associated in practically all of the depredations caused by *pini*, and is recorded in the literature in a number of cases under the name of *pini*. You are no doubt familiar with the economic importance of *Diprion pini* in Europe. It is highly important that immediate measures be taken to combat this injurious insect as it has a large number of host trees and would no doubt adapt itself readily to the conditions in America, where, if it were thoroughly established without its parasites, it would do a great deal of damage.

With Mr. Rohwer's help and approval, a brief article, calling attention to the presence of this insect in America and containing a description and illustrations, was prepared and sent to the Journal of Economic Entomology for the June number. (See Vol. 8, page 379.) The illustrations are reproduced as plate VII of this report.

DISTRIBUTION IN CONNECTICUT.

At the time of publishing the article, this insect had been found only in New Haven. Since then other areas have been examined

with the result that the larvae were found in five separate towns, as follows:—New Haven, Derby, Hartford, New Canaan and Greenwich. The pest is, therefore, apparently established within the state and perhaps already occurs in other states. It is therefore probably too late to carry out exterminative measures with success.

DISTRIBUTION AND DAMAGE IN EUROPE.

As there is some question whether or not *simile* is distinct from *pini*, its distribution as given in the literature is rather uncertain. In some cases both species are mentioned as occurring together, and in others, all injury is credited to *pini*.

For several years *Lophyrus pini* has seriously damaged the pine forests of Southwestern Russia,* especially the young trees. This species was particularly destructive in France† in 1906, and it has also done damage in Prussia and in Sweden. In England it is said to injure Scotch Fir‡ as well as pine.§

HABITS AND INJURY.

The larvae of the first brood feed upon the older, instead of the newly-formed leaves. When the new leaves become mature they may serve as food for the larvae of the second brood. In this way the larvae are able when abundant to entirely defoliate the tree, which will then soon die. Plate IX shows two trees, perhaps six or seven feet tall, which were almost defoliated. Some of the cocoons are fastened to the twigs of the host tree as shown on plate VII, 3. Others are found beneath the dead leaves and other rubbish on the ground. In Europe it is said that the first brood cocoons are fastened to the twigs, and those of the second brood placed upon the ground. In our breeding cages, all cocoons were made on the twigs.

LIFE HISTORY.

There were two complete generations in our breeding cages in 1915, and males of the third brood emerged late in the fall.

* Review of Applied Entomology, Vol. I, pp. 395 and 493, 1913.

† A. Barbey, *Traité d'Entomologie Forestière*, p. 269, 1913.

‡ W. E. Collinge, *A Manual of Injurious Insects*, p. 217, 1912.

§ E. A. Ormerod, *Manual of Injurious Insects and Methods of Prevention*, p. 250, 1890.

There were no females of the third brood, but as some of the first-laid eggs of this brood failed to hatch on account of the food becoming dry, it is possible that a third brood may occur under favorable conditions. These broods are not well separated. The first adults emerged from their cocoons in April and continued to emerge through May and even until July 6th. Meantime the early-hatched larvae had reached maturity and had spun their cocoons by the middle of June.

The second brood larvae feed during August and September. The larval state, on the average, lasts about 30½ days.

This species like many other sawflies is strongly parthenogenetic; unfertilized eggs not only hatched but the larvae developed normally to the pupa stage, in which condition they are now passing the winter.

FOOD PLANTS.

In Connecticut we have found the larvae feeding upon the white pine, *Pinus strobus*; the Japanese or Bhotan pine, *P. excelsa*; the Austrian pine, *P. laricio* var. *Austriaca*; the Scotch pine, *P. sylvestris*; the Mugho pine, *P. montana*; the Korean pine, *P. Koraiensis*; *P. densiflora*; *P. cembra* and *P. flexilis*. Newly-hatched larvae died on Austrian pine but after the first molt were able to mature upon it. Probably the older larvae will be able to subsist upon almost any species of pine and possibly upon other conifers.

DESCRIPTION.

The following description was published in the Journal of Economic Entomology, Vol. 8, page 380, and should enable one to identify the insect:

EGG.—The eggs are laid end to end in slits made along one of the ridges at the edge of the needle. The eggs are pale blue in color, smooth and slightly shining. The sides are parallel with the ends rounded. Length, 1.25 mm., thickness, .33 mm. In the material examined the newly laid eggs were slightly separated in the slits. The eggs before hatching increase in size, becoming crowded in the slits so that the ends are flattened like peas in a pod.

LARVA.—Length, 25 mm. (1 inch) to 28 mm. (1 1/8 inches). Thickness, 4 mm. (5/32 inch). Head black, body greenish yellow with a mid-dorsal double stripe of brown extending the entire length. On either side of the dorsal stripe is a yellow stripe broken with transverse markings of brown. The remainder of sides dark brown with many

irregular yellow or whitish spots. Ventral surface pale yellow or white. Pro-legs yellow with a transverse black mark at base, true legs marked with black and yellow.

COCOON.—9 mm. long (about $3/8$ inch), thickness about 5 mm., oval in shape, tough leathery and fairly smooth. Color, sepia.

MALE.—Wing-spread, 14 mm. ($9/16$ inch). Length, 7 mm. Large pectinate antennæ. Head and pronotum coarsely punctured. Head, antennæ and body, black. Cerci and tip of the last abdominal segment, orange. Legs yellow, with the trochanters and basal two-thirds of the femora, brownish black.

FEMALE.—Wing-spread, 20 mm. (little over $3/4$ inch). Length, 8 mm. ($5/16$ inch). Robust, head and antennæ black. Thorax coarsely punctured, yellow with a large shield-shaped black spot on mesothorax, extending from the anterior margin and covering about two-thirds of the space between the parapsidal grooves. On either side are a pair of L-shaped black marks which approach each other posteriorly. Posterior margin of the mesothorax, postscutellum and prosternum, black. Abdomen yellow with dorsal surface of 3d, 4th, 5th, 6th, and the anterior portion of 7th segment, black. Legs yellow with the outer surface of hind femora, the apex of the middle and hind tarsi, dark.

Other illustrations of cocoons and larvae are shown on plate VIII.

PARASITES.

One dipterous and three hymenopterous parasites have been reared from *Diprion simile* in Connecticut: all are native American species and we are indebted to Mr. S. A. Rohwer of the Bureau of Entomology for their identification. Tachinid eggs are frequent upon the larvae and one adult fly emerging from the cocoons proved to be *Exorista petiolata* Coq. Of 152 overwintering cocoons, 46 or about 31 per cent. were parasitized by a small chalcid fly, *Pachyneuron (Dibrachys) nigrocyaneus* Norton. One specimen each has been reared of the ichneumonid, *Hemiteles utilis* Norton, and a species of *Cerambycobius*.

It is evident that *Diprion simile* is freely attacked here by American species of parasitic Hymenoptera and Diptera, but it is not known as yet whether any European species were brought into this country in the cocoons of the sawfly.

POSSIBLE MANNER OF INTRODUCTION.

It will probably never be known just how this sawfly was introduced into the United States. The most plausible theory is that it came on nursery stock.

Since 1909, when nests of the brown-tail moth were found on nursery stock coming into this country, an attempt has been made to inspect all shipments of field-grown woody stock coming into Connecticut from foreign sources. At first we were unable to trace all shipments and therefore a few escaped inspection, but since the establishment of the Federal Horticultural Board in 1912, the system of notices and permits has enabled us to make the inspection more complete. On account of the blister rust diseases and the pine shoot moth, all pines are now prohibited from entering the United States from Europe.

It is quite probable, however, that a few cocoons attached to the leaf-covered twigs escaped notice, and cocoons might easily be brought in the burlap-covered ball of earth at the roots. Possibly this insect was thus introduced in the very nursery where it was first discovered, though several Connecticut nurseries have imported pine trees, and any one of them might easily have become infested in this way.

DANGER TO PINE GROWING IN AMERICA.

Just how serious a pest this sawfly may become in the United States is impossible to foretell. Any introduced insect which feeds upon an important crop is dangerous; doubly so if its natural enemies are left behind. The food plants of *Diprion simile* are abundant here and the climate seems to favor it. Therefore, it is probably a question of parasites and other natural enemies. It is encouraging to learn that our native species attack it.

MEANS OF CONTROL.

In the infested nurseries the owners were required to spray the pines with lead arsenate (3 lbs. in 50 gallons of water) late in summer when the larvae were feeding. Afterwards a careful inspection was made of each tree and all cocoons removed. These precautions seemed necessary to reduce to the minimum the danger of further distributing the pest on nursery stock.

Pines planted on private grounds can likewise be sprayed, but the cost would be prohibitive in large forests.

In Europe, raking up and destroying the leaves and other rubbish under the trees in fall is recommended to destroy the cocoons.

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THE LARCH SAWFLY.

Lygæonematus (Nematus) erichsoni Hartig.

Although the larch sawfly has undoubtedly occurred in Connecticut for many years, not since this department was established in 1901 has the insect been noticed by any member of the staff until the season of 1915. On July 13th, larvae were received by mail from Mr. N. S. Stevens of East Canaan, from trees on the place of Mrs. Annis Porter. As most of the larvae were either dead or about ready to transform, Mr. Zappe was sent to the place at once to make a record of the conditions there. He found two larch or tamarack trees growing in a grove of white pines, which had been entirely defoliated by the larvae. At this time nearly all had transformed and Mr. Zappe collected a good number of pupae from the surface of the ground under the trees. Later Mr. Lowry happened to visit this corner of the state and made a photograph of these trees, which is reproduced on plate V, b.

On July 14th, a number of living larvae were received from Mr. Francis H. Adriance of New Canaan, who wrote as follows:

I am sending under another cover a number of caterpillars or worms which I found eating the foliage of a Japanese larch tree, which has been growing on my place for a number of years, and until this season has been free from insect pests.

On July 16th Mr. Walden visited Woodstock, where a small area of larch had been partially stripped, and made the photograph reproduced on plate V, a.

The writer visited Windham county the last week of July and from the train observed several small areas of larch which, on account of the defoliation, were brown as though damaged by fire.

Mr. Davis also observed that this insect was feeding on larch trees in Pomfret and in Waterford, yet certain trees in Putnam and Plainfield showed no signs of attack.

Mr. W. O. Filley, State Forester, observed the caterpillars on one large tree in Litchfield, two or three large trees in Cornwall, and on a few small trees in Union. Assistants inspecting nurseries in various parts of the state in August and September, examined many small trees, which were not eaten, and a small larch on the Station grounds was also examined and found not infested.

DISTRIBUTION AND DAMAGE IN AMERICA.

The larch sawfly was first noticed in this country in Massachusetts by Hagen, who published in 1881 a note in the Canadian Entomologist regarding the insect. In 1881 and 1882 it caused much damage in Maine. In 1883, many square miles of larch swamps in New York were infested. In 1892 it was reported from Pennsylvania as injuring hemlock. In 1910, according to Ruggles,* it caused great injury to tamarack in Northern Minnesota. At various times there have been destructive outbreaks in southeastern Canada, the worst occurring in 1882 and in 1906. Hopkins† estimates that it has killed from 50 to 100 per cent. of the mature larch over vast areas in the northeastern states and southeastern Canada during the extensive outbreaks since 1880.

In Canada the pest seems to be gradually spreading westward and Dr. Hewitt‡ states that in eastern Canada (and probably the same holds true for the northeastern United States) the distribution of the larch sawfly corresponds with that of the American larch.

DISTRIBUTION AND INJURY IN EUROPE.

The larch sawfly has been reported at various times during the last 75 years in Germany, Switzerland, Holland, Denmark, Sweden, Finland, England, Scotland and Wales. According to Dr. Hewitt§ this insect is not known to occur in France but has

* Canadian Entomologist, Vol. 42, page 93, 1910.

† Bureau of Entomology, Bull. 58, page 60, 1909.

‡ Can. Dept. of Agr., Bull. 10, 12, 1912.

§ Can. Dept. of Agr., Bull. 10, second series, page 9, 1912.

been destructive in Great Britain, where in the Lake District 15,000 trees had died in 1909 from its attacks.

FOOD PLANTS.

The larch sawfly feeds upon the various species of larch (*Larix*) including the American larch, *Larix americana*; the European larch, *L. europæa*, the Japanese larch, *L. leptolepis*, and the Siberian larch, *L. sibirica*. Although it was reported as attacking hemlock in Pennsylvania in 1892, Dr. Hewitt* was unable to make it feed upon various species of spruce (*Picea*), fir (*Abies*), and pine (*Pinus*) in Canada.

HABITS AND INJURY.

The larch sawfly injures the trees, in both its adult and larval stages—the female by cutting into the new shoots to lay eggs, and the larvae by devouring the leaves. Dr. C. Gordon Hewitt has published illustrations showing the distorting effect on the branches by the injury to the shoots by the adults, which he describes as follows:

In depositing the eggs, the sawfly invariably chooses the young, green, terminal twig in which to insert the eggs, as I have already indicated in describing the oviposition. The result of the injuries inflicted during this process is that the terminal twig either dies or is permanently injured and distorted. Where a large number of eggs have been deposited all round the length of the young terminal shoot, it usually turns brown and dies and the presence of these curled-up, brown, dead terminal shoots often serves to indicate the presence of the larvae on the tree. When the terminal shoot is killed in this manner the growth is arrested and the form of the tree may be affected. In many cases the eggs are deposited along one side only of the young terminal shoot, with the result that the growth on that side is seriously interfered with and retarded, causing the shoot to curl in the direction of the injured side. The extent of the curvature varies, but not infrequently it will curve through a complete circle and continue growing in the original direction.

When the apical terminal shoot is affected in either of the above ways, the result is serious to the growth of the tree. If the shoot is killed, its place is usually taken by a lateral shoot which will affect the straight character of the subsequent timber. Where the shoot is not killed, but is bent or curled, a permanent kink may be caused. In those parts of Canada in which the sawfly was abundant and destructive in the years

* Ibid.

1882-6, the effect of the injury of the sawflies to the apical terminal shoots of the young trees constituting the second growth at that time on the growth of the trees is very plainly shown by the crooked character of the trunks of young trees which have now grown up and are upwards of thirty years old. The effect of this type of injury upon the young trees whether the growth is natural or planted is a serious one as affecting the ultimate value of the trees as timber. Further, it is an injury which cannot be prevented if the adult sawflies are present.*

As soon as the eggs hatch the young larvae begin to feed; at first eating notches in the sides of the leaves, causing them to wither and turn brown. Later they devour the entire leaf, commencing at the tip. The defoliation usually begins on the lower branches, and if the insects are abundant the entire tree is soon stripped. Closely-planted trees and those growing in a native forest are more seriously injured than isolated or scattered larch trees growing in the open. This is because the tree in a thick woodland has only a few leaves at the ends of the branches, or perhaps at the top. If these are eaten there are only a few buds to produce new leaves and consequently the tree is unable to manufacture cell tissues from its sap. The tree grown in the open country is often covered with leaves, from the tip to the base of the branches and sometimes on the main stem. Under these conditions, frequently some of the leaves escape destruction, and the defoliation, therefore, is not complete. Even when all leaves are eaten, the tree is able to recover sooner than a crowded tree in the forest, probably on account of the more abundant supply of light, air and moisture. In cases of complete defoliation in midsummer, especially if followed by rains, the buds which normally remain dormant until the following spring, open and produce tender leaves which are usually killed by the early frosts. The trees are not able to form other strong buds for the next year and consequently they are greatly weakened. Complete defoliation for three successive years will kill the trees. Even where the defoliation is only partial, the vitality of the tree is so reduced that it soon falls a prey to the bark beetles of the family *Ipidæ* or *Scolytidæ*. One of the most destructive of these is the eastern larch beetle, *Dendroctonus simplex* LeC.

* Division of Entomology, Can. Dept. of Agr., Bull. 10, second series, page 18, 1912.

LIFE HISTORY.

There is probably only one brood each year. The winter is passed as a larva inside the cocoon, the real pupa not being formed until the following spring as is the case with other sawflies.

The eggs are laid in May in Ontario, and hatched in eight to ten days. The larvae then feed for a period varying from three to four weeks, then make their cocoons. The different individuals, however, do not all emerge and undergo their transformations at the same time. Thus, eggs from late-emerging females may produce newly-hatched larvae which feed side by side with those which are nearly mature.

The larch sawfly, like many other sawflies, is parthenogenetic: that is, the females lay unfertilized eggs from which the larvae hatch and develop normally. Consequently the females greatly outnumber the males.

Dr. C. Gordon Hewitt, Dominion Entomologist of Canada, records* obtaining 6,158 females and 23 males from a total of 6,181 cocoons.

DESCRIPTION.

EGG.—About 1.5 mm. in length, white, cylindrically oval, though on account of unequal pressure where deposited the eggs vary somewhat in shape. The eggs are wholly inserted in a slit made by the female in the tender terminal shoot.

LARVA.—The newly-hatched larvae are greenish-white and 2 mm. long. In a few hours they show a green color and the head becomes brown. They have the habit, common to many sawfly larvae, of turning their posterior extremities upward and forward over their backs. They do not feed upon the leaves of the terminal shoots but devour those around its base. The fully-grown larva is from 16 to 18 mm. (about three-fourths of an inch) in length and of a dull grayish or olive green color dorsally with a small area back of the head and the ventral surface pale green. The head and legs are black. The skin is folded transversely and on some of these folds are rows of minute warts or tubercles. Small scattered tubercles occur on the back and small brownish spines are scattered over the body. There are seven pairs of abdominal appendages or prolegs. The mandibles have four teeth and the maxillae are four-jointed.

There are probably five instars, or stages between molts, from the hatching of the egg to the spinning of the cocoon.

* Division of Entomology, Can. Dept. of Agr., Bull. 10, second series, page 13, 1912.

COCOON.—The cocoon is about 10 mm. long and half as thick, cylindrical, with ends bluntly rounded. The color is dark brown and the outside is firm and tough. It is fibrous or leathery in appearance. The cocoons are formed in the ground or on the surface underneath the litter and near the base of the tree. Inside the case the larva remains until the following spring, assuming the pupa stage about two weeks before the adult emerges.

ADULT.—The female is about 11 mm. (nearly half an inch) in length with a wing-spread of about 20-22 mm. (four-fifths of an inch). Head, antennae, thorax, base of first segment and apex of abdomen shining black, distal portion of first, second, third and fourth abdominal segments, femora, tips of anterior tibiae and their tarsi orange-yellow; basal two-thirds of tibiae yellowish-white. Forewings infuscated near center, anal vein whitish, costa fulvous, all other veins black; rear wings not infuscated, veins black.

Male smaller and more slender than the female, black except antennae, a part of the first, second, third, fourth and all but the lateral portions of the fifth and sixth abdominal segments, and legs, which are reddish-yellow. Wings as in female.

Larvae and pupae are shown on plate IV, a.

NATURAL ENEMIES.

The chief factors in the control of the larch sawfly are its natural enemies, which consist of birds, mammals, a large number of parasitic and predaceous insects, and a fungus parasite. The natural enemies have been studied and recorded in Canada by Dr. Hewitt and it is from his publications that a large part of this chapter is taken.

The meadow mouse and the deer mouse destroy large numbers of the cocoons by gnawing holes at one end and eating out the contents.

Several kinds of birds feed upon the younger larvae.

An ichneumon fly, *Mesoleius tenthredinis* Morley, is parasitic on the larch sawfly in England and has been introduced into Canada and liberated at several places.

A small native chalcid parasite, *Cæloplastis* (*Pteromalus*) *nematicida* Packard occurs in Massachusetts and no doubt also in Connecticut. Apparently this chalcid is an important natural check on the species.

A species of *Diglochis* parasitized from ten to fifteen per cent. of the cocoons in Minnesota in 1909-1910. A species of *Perilampus* emerged from cocoons collected in Wisconsin in 1909, and Lintner reared a *Microgaster* in New York in 1885.

In England, *Microcryptus labralis* Grav., *Aptesis nigrocinctor* Foerster, *Spilocryptus incubitor* Ström, *Cælichneumon fuscipes* Grav., *Graticheumon annulator* Fabr., and *Cryptus minator* Grav., all ichneumon parasitic flies, have been reared from the larch sawfly.

A tachinid fly, *Frontina* (*Masicera*) *tenthredinidarum* Townsend, was reared from *L. erichsoni* in New Brunswick in 1910 and two species of *Exorista* attack this sawfly in England.

A soldier bug, *Apateticus* (*Podisus*) *modestus* Dall., preys upon the larvae in Quebec and in New York state. This species occurs also in New Jersey and probably will be found in Connecticut.

A fungus, *Isaria farinosa* (Dicks) Fr., grows upon the cocoons in Canada and in England, destroying the insect within. This fungus appears to be widely distributed and may prove an important check under favorable climatic conditions. Its artificial use, however, is of questionable value.

CONTROL MEASURES.

Spraying.—In small plantations like those of Connecticut, and with ornamental trees in parks and on private grounds, spraying with poison, preferably lead arsenate, will prevent defoliation. Just what proportions should be advised without definite experiments in Connecticut is a question. It is almost certain that three pounds of the poison in fifty gallons of water will suffice, and it is more than probable that half as much poison will answer, as sawfly larvae are easily killed. In the larch plantations of Connecticut, which have medium-sized trees and are only a few acres in extent, spraying by means of one of the large power sprayers like that shown on plate IV, b, of this report is perfectly practicable and can be done at a cost varying between five and ten dollars per acre, depending, of course, upon accessibility, nearness of water, and the cost of labor. If the trees are small, it will cost much less. In large forest areas, even this kind of spraying treatment would be out of the question. A few ornamental trees can easily be sprayed with hand-power pumps. Spraying, in order to be effective, should be done during the first half of June.

Destroying Cocoons.—Raking together the cocoons from under the trees and burning them has been suggested as a control measure, but the cost of this is so great as to be prohibitive.

Banding of Trees.—As many of the larvae are disturbed by storms and drop to the ground, it has been recommended that sticky bands like tanglefoot be placed around the trunks of trees to prevent the larvae from returning to feed upon the foliage. As many will not drop to the ground at all, and others only after they have done considerable damage, this banding method seems to be of doubtful value, especially under Connecticut conditions. The cost, too, would probably approach that of spraying, which would entirely save the foliage for the season.

Mixed plantings as a Preventive Measure.—In order that forest trees may not be killed over large areas by the depredations of this insect, it has been suggested that the larch should not be planted exclusively in a pure stand on such areas but should be mixed with other species of trees. As the larch also thrives better in mixed plantings, this recommendation should by all means be carried out, even irrespective of the larch sawfly. Mr. W. O. Filley, State Forester, regards the white pine as perhaps the best kind of tree to mix with larch in forest planting.

Prepare for a possible infestation in 1916.—It is generally impossible to predict insect outbreaks and the writer has no desire to pose as a prophet, but common sense teaches us that on account of the presence of this in destructive numbers in certain parts of the state in 1915, there is a possibility of a similar or worse attack in 1916. All owners of larch should watch their trees during May and be prepared to spray before the leaves have been seriously injured.

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EXPERIMENTS IN CONTROLLING THE WHITE PINE WEEVIL IN 1915.

By B. H. WALDEN.

In 1914 experiments to control the white pine weevil were started in a two-acre block of white pine (No. 29) in the plantation at Rainbow. The land was planted in the fall of 1907 with 3-year transplants, and in the spring of 1914 the trees were from

3 to 5 feet high. Weevil injury was first observed in 1913, and the infested leaders were removed about the first of July.

At the time the experiments were started the leaders were missing from 93 out of a total of 2,882 trees.

This loss was not all due to attacks of the white pine weevil. The leaders are sometimes injured by sun scald, broken by snow, and possibly weakened by aphids, and it has been the practice in the plantations when cutting the weeviled leaders to remove all that are dying or are seriously injured from any cause.

The plan of the experiment was to apply various treatments to sections of this block for a period of years, the trees being at this time at the age when the weevils usually begin their injury, and continue the experiment each year until the trees were too large to treat.

The block was divided into four sections:

On the first section the leaders were sprayed with commercial lime and sulphur, one part in eight parts of water.

The second section was left untreated as a check.

On the third section the leaders were sprayed with dry lead arsenate, 1 oz. in a gallon of water (3 lbs. in 48 gallons).

On the fourth section the weevils were collected with a net as recommended in the Report for 1914.*

In 1914 the lime and sulphur and the lead arsenate were applied May 7th and 8th.

On the fourth block the weevils were collected five times, viz; May 7th, 14th, 21st, 28th and June 3rd.

In 1915 the lime and sulphur and the lead arsenate were applied May 7th and 11th.

Six collections were made with the net on the fourth block, on the following dates:

May 7th, 14th, 24th, 28th, June 4th and 10th.

The following table shows the results of such treatment in 1914 and 1915:

Treatment	Total No. Trees	No. Trees Weeviled	
		1914	1915
Lime and sulphur 1-8	830	2	2
Check	665	3	14
Lead arsenate 1 oz.-1 gal.	626	5	8
Net	761	6	7

* 14th Rept. State Ent. Conn., page 174.

In both 1914 and 1915 the smallest number of weeviled trees occurred where sprayed with lime and sulphur. In 1915 the lead arsenate and net gave about the same degree of freedom and the injured leaders were only about half as numerous as on the untreated or check trees.

Of course it will be necessary to continue these experiments for several years before any definite and conclusive results can be obtained.

FUMIGATING A GRAPERY WITH HYDROCYANIC ACID GAS TO KILL MEALY BUGS.

By B. H. WALDEN.

On January 20th, 1915, the writer superintended the fumigation with hydrocyanic acid gas of a grapery infested with mealy bug. This grapery was on a large estate in New Haven and the gardener had experienced considerable trouble with the pest. Various treatments, such as tobacco solutions and whale oil soap, had been applied without success. During the preceding season the house was infested to such an extent that it was necessary when cutting the grapes to wash practically every bunch to remove the bugs.

The house was 64 feet long and 24 feet wide, of modern construction and comparatively tight. The vines were planted along the side walls and had been pruned and scraped previous to fumigating.

The house contained approximately 17,440 cubic feet of space, and 5 lbs. of cyanide, or slightly less than $\frac{1}{2}$ oz. to 100 cu. ft., was used, the formula being as follows:

Cyanide	$\frac{1}{2}$ oz. to 100 cu. ft.
Commercial Sulphur Acid	1 oz.
Water	2 oz.

Four generators were used. Owing to a difference in size in the generators, $1\frac{1}{2}$ lbs. of cyanide was used in two, and 1 lb. in each of the others. The generators were placed on the ground through the center of the house, the larger ones being placed near either end.

The fumigation was started at about 5 o'clock in the afternoon and the house remained closed over night.

The treatment was successful, and no injury to the vines was observed. The crop of grapes was free from the mealy bugs, though the pest reappeared on the vines during the latter part of the summer, having been brought in from infested bedding plants growing near the grapery.

THE JUNIPER WEB-WORM.

Dichomeris marginellus Fabr.

On May 7th juniper twigs were received from Mr. George H. Hollister, Superintendent of Keney Park, Hartford, which had been webbed together and small larvae were feeding on the leaves in the web. The same kind of larvae upon *Juniperus communis* were received on June 7th from Mr. W. C. Homan of Meriden, and threatened to do considerable damage in ornamental plantings of this species. Mr. Hollister wrote:

I am sending a package containing a branch of *Juniperus communis* with the nests or webs and some insect larvae with which I am not familiar. Will you kindly tell me what they are?

From Mr. Homan's letter I quote as follows:

I am enclosing with this, a small branch cut from a common juniper, which was transplanted from the fields some four or five years ago and has grown very thriftily under cultivation ever since, but this year I find it completely infested with a small brown worm which has formed webmasses in nearly all the branches—similar to the one which I enclose. I also send a small bottle containing a few of the worms and chrysalids.

I have other junipers near the one from which this branch was taken, some of which are infested and others which are not. I also have red cedars growing nearby—none of which are infested.

I would like to enquire if you can advise any treatment to eradicate this pest, as I fear that I may lose all my junipers if the worms are not cleaned off. Any advice that you can give will be greatly appreciated.

In both cases it was advised that the worst branches be cut and burned and that the remaining portion of the junipers be sprayed with lead arsenate (3 lbs. paste or 1½ lbs. powder, in 50 gallons water).

Later the adults were obtained in our breeding cages and proved to be *Dichomeris marginellus* Fabr. Both larva and adult are shown on plate XVI, b and c.

This web-worm has probably been sent to the laboratory in preceding years but we thought that it might be *Phalonia rutilana* Hubn. and the adults were not reared. On November 4th, 1909, webbed juniper twigs were received from Greenwich, with the statement that the larvae feed all winter and do much damage to ornamental junipers. On May 21st, 1912, similar webbed twigs from red cedar were sent to the office from Wilton and a note was published in the report for 1912, page 295. This note states that the adults were not reared but that probably the insect was *Phalonia rutilana* Hubn., a species listed by Dyar* as occurring in Maine and New York. On April 9, 1914, larvae on Irish juniper were received from Greenwich. I am now satisfied that these insects were not *P. rutilana* but *Dichomeris marginellus* Fabr., which was first reported in New York State in 1910 by Dr. Felt.† In our specimens the larvae are nearly twice as long as the measurements given by Felt, but otherwise the description fits fairly well.

LARVA.—Length 10-12 mm. Body light brown (almost mauve) with narrow median longitudinal stripe, and two broader dorso-lateral stripes of darker or chocolate brown. Head, thoracic shield and legs dark brown or black, shining. The body segments bear scattered light-brown hairs, the length of which equals one-half the thickness of the body.

ADULT.—Length 7 mm., wingspread 15 mm. Forewings brown, with white front and rear margins, the white disappearing before reaching the apex of the wing. Rear wings heavily fringed, uniform pearl gray above and below, shining. Legs light brown, antennæ long and slender, dark brown. Thorax and abdomen above and below light brown with a tuft of creamy white hairs on head and prothorax.

The life history of this insect seems not to have been carefully worked out. The moths appear early in June. The larvae feed together in the webbed mass and the cocoons are formed in the web. Dr. Felt‡ states that the larvae feed quite as readily upon the dried as upon the fresh leaves and that there may be more than one generation each year.

In case of a serious attack, a thorough spraying of lead arsenate should prevent further damage. This application should

* H. G. Dyar, List of N. A. Lepidoptera, Bull. 52, U. S. National Museum, page 486, 1902.

† E. P. Felt, Report N. Y. State Entomologist, 26, page 35, 1910.

‡ Ibid.

be made when the larvae are feeding, and preferably when they are small. The webs will then also be small, and if the larvae can then be killed little damage will result.

THREE SPECIES OF SCALE INSECTS NEW TO CONNECTICUT.

Leucaspis japonica Cockerell. On October 27, 1914, some material was received from the Frost & Bartlett Company of Stamford, which on superficial examination was pronounced oyster shell scale. The scales were on Norway maple. More material, including infested stems of California privet, were received from the same source on December 8, 1914, with a statement that the material was collected in Greenwich. Instead of the oyster shell scale, it proved to be a Japanese species, *Leucaspis japonica* Ckll.

The Frost & Bartlett Company sent some material from the same place to Dr. E. P. Felt, State Entomologist of New York, and Dr. Felt published a brief note regarding it in *Journal of Economic Entomology*, Vol. 8, page 160.

During the summer of 1915 (August 3rd) after a storm, a branch was broken from one of the silver maple trees on McKinley Avenue, New Haven. The writer noticed one day in passing that this branch was thoroughly covered with scales and on examination they proved to be *Leucaspis japonica*. The entire branch, which was perhaps one and one-half inches in diameter at the fracture, was then taken to the laboratory so that we now have considerable of this material.

The female scales are about the same color and greatly resemble those of the oyster-shell scale, though somewhat smaller and broader in relation to the length. They are about the same color as the bark. The males are not tricarinate as in the genus *Chionaspis*. Under the microscope the pygidium does not show any groups of ventral glands, as in the oyster shell scale, though there are a number of scattered glands.

This insect is shown on plate XII, c.

In the summer of 1910, while the gipsy moth work was in progress at Wallingford, Mr. Walden and the writer noticed on South Orchard Street several silver maples on which many of

the lower branches had been killed or severely injured by a scale insect which we took to be the oyster shell scale. No microscopic examination was made of it, and little attention was afterward paid to it. It is quite probable, however, that this scale on the trees in Wallingford was also the Japanese species.

Little seems to be known, or at least little has been published about this insect and its life history. Probably it can be controlled by some method of spraying but until some knowledge is gained of the life history of the species we shall be unable to suggest a vulnerable point of attack.

Lepidosaphes newsteadi Sulc. On February 3rd, 1915, we received from the Hartford Forestry Company some leaves of the umbrella pine, *Sciadopitys verticillata*, which were infested with unfamiliar scale insects. The scales were clustered along the veins, were longer than broad, and gray with whitish margins, as shown on plate XII, a. Specimens were sent to the Bureau of Entomology at Washington, where they were identified as *Lepidosaphes newsteadi* Sulc.

This species was described from Europe on tea, *Thea japonica*, and Kuwana has described the variety *tokionis* on *Codiaeum* from Japan. Very little has been published regarding *newsteadi* and apparently little is known of its life history or of its distribution and food plants. It is probably too rare to become a pest.

Diaspis echinocacti Bouché var. *cacti* Comstock. This scale insect was received on *Phyllocactus* from West Hartford January 4, 1916. This is a common greenhouse scale which may attack nearly all kinds of cactus plants. It will probably not live out of doors in Connecticut, and has not hitherto been recorded from the state. It is nearly circular in outline and light gray or nearly white and is shown on plate XII, b. The remedies used against other greenhouse scales will probably control this species.

MOSQUITO CONDITIONS IN CONNECTICUT IN 1915.

LEGISLATION.

In the report of this Station for 1913, page 242, mention is made of a law passed by the General Assembly of that year and of another measure which passed the House and Senate but was vetoed by the Governor.

A meeting of those interested in anti-mosquito work was held December 4, 1914, and the situation discussed. The meeting was unanimous in passing a resolution authorizing the chairman to appoint a committee to amend the former bill, to introduce it into the legislature, and to work for its passage. Accordingly this was done.

In due season a hearing was held before the Committee on Public Health and Safety, to which the matter was referred. A goodly number favored the measure and there was little opposition. When the measure came before the Clerk of Bills, he considered that it was not in proper form and needed redrafting, although the same bill substantially in the same form had been passed upon by the same Clerk at the preceding session.

Consequently the bill was entirely changed and in due time became a law, but on account of the unfavorable financial condition of the State no appropriation was granted. This law follows:

CHAPTER 264, PUBLIC ACTS OF 1915.

AN ACT PROVIDING FOR THE ELIMINATION OF MOSQUITO BREEDING PLACES OR AREAS.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. The director of the Connecticut agricultural experiment station may make rules and orders concerning the elimination of mosquitoes and mosquito breeding places or areas, and he or his agents or employees may enter upon any swamp, marsh, or land to ascertain if mosquitoes breed thereon, or to survey, drain, fill, or otherwise eliminate any such mosquito breeding place.

SEC. 2. Whenever sufficient funds have been raised for the purpose by the state or by any city, borough or town in which such swamp, marsh, or land is located, or by voluntary contributions, said director shall drain, fill, or otherwise treat such place or area or cause any such place or area to be drained, filled, or mosquito breeding therein otherwise eliminated, and shall cause notice of any such order to be given to the owners of any such place or area by publishing a copy of such order containing a description of the place or area proposed to be drained, filled, or mosquito breeding therein otherwise eliminated, with the proposed plan of elimination, at least three times in a newspaper having a circulation in the locality where such place or area is situated, such publication to begin not less than ten days before beginning such elimination. Any person claiming to be aggrieved because of any such proposed draining or filling may, within ten days after publication of such notice, apply

to the superior court or any judge thereof in the county in which such land is located, for relief from such order, and shall cause a copy of such application to be served upon said director not less than six days before hearing thereon, and said court or such judge may make any proper order concerning the proposed plan of elimination of mosquito breeding.

SEC. 3. Any city, borough, or town wherein any such place or area has been drained to the approval of said director shall keep in repair and free from obstruction any ditch, canal, or drain connected with such place or area, and, upon order of said director, shall construct and maintain suitable tide gates, and may appropriate funds for such purposes and for use under the provisions of this act.

SEC. 4. Any person obstructing the work of examining, surveying, or ditching, or otherwise treating such mosquito breeding areas, or obstructing any ditch, canal, or drain, or the natural outlet of any marsh forming mosquito breeding areas, shall be fined not more than one hundred dollars, or imprisoned not more than ninety days, or both.

SEC. 5. This act shall take effect from its passage.

Approved May 18, 1915.

The Attorney General has given an opinion to the effect that Section 2 does not apply to any work done prior to the passage of the act.

A NOTABLE MOSQUITO YEAR.

Seldom are mosquitoes so abundant along the Connecticut coast as they were in 1915. The salt marsh mosquito, *Aedes sollicitans* Walker, was chiefly responsible for the mosquito nuisance. It was breeding in nearly every undrained salt marsh. The chief contributing causes seemed to be an abundance of rain in July and August coupled with high tides. The latter flooded many of the salt marshes and the rains kept the depressions supplied with water. Consequently many communities were aroused and considered the advisability of draining salt marsh areas.

MAINTENANCE WORK.

In New Haven the Anti-Mosquito Committee of the Civic Federation raised money and employed Mr. James E. Hitchcock to examine the ditches, clean them when necessary, and to scout for mosquito-breeding places around New Haven. In like manner all ditches cut in 1912 have been kept in working order since.

A small area, owned by the New York, New Haven & Hartford Railroad Company, and situated between the Boulevard and the tracks of the Berkshire Division, was a bad breeding place in 1915 and was ditched at the owner's expense by Mr. Hitchcock.

A portion of West River was oiled by Mr. Hitchcock to kill the larvae of *Culex pipiens* which were found breeding there late in July.

Ditches in Greenwich, Stamford, Darien, Norwalk and Fairfield have also been maintained.

MOSQUITO SURVEYS.

As the new law provides a method by which mosquito drainage may legally be carried out, several communities asked for surveys. Thus Mr. Walden spent two days in July at Saybrook and Lyme, and two more in August at Stonington in company with Mr. P. L. Buttrick. As no appropriation for this work was made by the legislature, it was necessary that funds be raised locally to cover the expenses of these surveys. Thus Mr. P. L. Buttrick was appointed a special agent of the Station to make a detailed survey of the region at the mouth of the Connecticut River. This work was done in August and September under our direction, and the report with colored map was printed as Bulletin 189 of this Station, the cost of printing being borne in part by the Old Saybrook Town Improvement Association. As only a small edition of this bulletin was issued, the paper is made a part of this report and may be found on page 144.

The report of Messrs. Walden and Buttrick for the town of Stonington was similar in scope, and though not printed, a type-written copy with map was submitted to the Stonington people interested in the work.

Similar surveys were made by Mr. Buttrick for the towns of Branford and Westbrook, where mosquito drainage is contemplated. These were made independent of the Station, though the same methods were followed of classifying the breeding areas according to a scheme original with Mr. Buttrick, and of showing these areas in colors on a map drawn to a convenient scale. Mr. Buttrick also did some survey work in Greenwich to supplement work done there in 1913 and 1914.

In addition to the towns mentioned above, portions of Guilford and Madison are interested and have planned to raise money for actual drainage work.

ANTI-MOSQUITO MEETINGS.

Mr. Walden spoke at a public meeting at the town hall in Old Saybrook on July 31st; Dr. E. H. Jenkins and Mr. Walden spoke at a similar meeting at the Yacht Club, Sachem's Head, August 14th, and the State Entomologist gave an illustrated lecture on mosquitoes at Borough Hall, Stonington, September 4th.

REPORT ON A MOSQUITO SURVEY AT THE MOUTH OF THE CONNECTICUT RIVER

By P. L. BUTTRICK, SPECIAL AGENT

OF THE

CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONN.

AUGUST-SEPTEMBER, 1915

PREFATORY NOTE.

The Director of the Connecticut Agricultural Station is authorized by law to make rules and orders regarding the elimination of mosquitoes and personally or by his agent to enter premises for inspection and to survey and to eliminate by drainage, filling or otherwise treating mosquito-breeding areas. Due notice of the proposed plan of elimination must be given by him, and any one claiming to be aggrieved by the proposed operations may appeal to the Superior Court.

No funds are provided by the State for the purposes of this act and therefore the work of mosquito elimination can be undertaken only at the expense of individuals or local organizations.

The following survey was made at the request and at the expense of The Old Saybrook Town Improvement Association. Dr. W. E. Britton, the State and Station Entomologist, who has had years of experience and study of the mosquito problem in this State, was given the general superintendence of the matter and the survey itself was made by Mr. P. L. Buttrick. Mr. Buttrick has made a number of mosquito surveys in other parts of

the State and the principles of work and form of the present survey will have interest and value to other communities which are considering the elimination of mosquitoes. The object of such a survey is to ascertain the location and character of mosquito-breeding places, to determine how they can best be eliminated and to roughly estimate the probable cost. It is believed that this survey, with the accompanying map, makes it possible for those interested to decide what work is most necessary, where money can best be spent and the approximate cost of any portion or of all the work.

E. H. JENKINS, *Director.*

INTRODUCTION.

Area Covered. This survey covers all the salt and brackish marshes in the townships of Old Saybrook and Old Lyme, together with portions of those in Essex and Lyme. Particular attention has been given to the marshes bordering the river. Fresh marshes and other mosquito-breeding places have been included where it seemed that they were of sufficient importance to warrant it. In many cases the notes on fresh water areas are not as complete as those on the salt marsh areas. The notes for the towns on opposite sides of the river are given separately. In Saybrook the notes on salt and fresh water areas are separated; in Lyme this was impracticable though when possible the estimates are given separately.

General Observations on Salt Marshes. The region of this survey contains probably the largest group of salt marshes in the state east of New Haven. The total area of salt and brackish marshes is:

Old Saybrook	1,373.5	acres
Old Lyme	1,383.1	"
Lyme	492.5	"
Total	3,249.1	"

These marshes vary in character in proportion to the amount of submergence which they undergo by action of the tide. There are at least four classes as follows:

Areas covered with wild rice (*Zizania aquatica*) and vegetation of like nature which are flooded either constantly or at every high tide. They are known as tidal flats and do not breed mosquitoes. No areas of this class are shown on the accompanying map.

The next class includes the so-called sedge grass marshes which are quite generally flooded at perigee and apogee tides and upon which water frequently stands for a considerable time thereafter. Marshes of this character are inveterate mosquito breeders. The vegetation upon them, although sometimes cut for hay, is generally of inferior value.

Marshes less frequently flooded and standing at a higher level than those just mentioned constitute the next class. They are generally covered with hay grasses of various kinds, the most common of which are popularly called black grass (*Juncus gerardi*) and red top, or red salt grass (*Spartina patens*, formerly known as *S. juncea*). These marshes breed mosquitoes more or less, but only under very exceptional conditions do they breed them as abundantly as the preceding.

As the marsh stretches further and further back from the shore it is less frequently flooded by salt water and more frequently by fresh water. This change shows in the vegetation, which is usually composed either of a sedge called 3-square, (*Scirpus*), from the triangular shape of its stems; or of cat-tails. Such areas vary from brackish to entirely fresh, but when the latter stage is reached, the nature of this herbage changes to that of some of the types of purely fresh marshes. Marshes of this type are casual breeding places, sometimes breeding both salt and fresh water mosquitoes. The borders of many of the marshes, particularly on the Lyme side of the river, consist of tidal flats.

The Sound marshes, particularly on the Saybrook side, are mostly of the second or sedge grass type and the same is true of those at the mouth of Black Hall River and on South Cove, and it is upon them that the worst mosquito breeding takes place. Further back most of the marshes are of the hay grass type. Above the railroad bridge they become less and less salt in character and finally above Essex the salt marsh entirely disappears.

Along the Sound shore of Lyme conditions are somewhat different. Here the tidal current sweeps in from the east and the

heavy east winds which blow from the open Atlantic have piled up the sands along the shore and partly or completely blocked the marsh drainage, turning many salt marshes into fresh ones without outlets, or into brackish ones with only occasional outlets. As far as mosquito breeding is concerned, these factors have produced rather special conditions which will be discussed later.

Observations on Mosquito Breeding. No attempt was made to identify all the species of mosquitoes found. They were grouped into the general classes of salt marsh species, fresh water species, and malarial species. The most common mosquito is the ordinary banded Salt Marsh Mosquito (*Aedes sollicitans*, Walker), which breeds in flood pools wherever they occur on the salt marshes. This species was found breeding under somewhat unusual conditions far up the river above the area of salt marshes, both in drainage ditches on Nott's Island, which is a reclaimed fresh marsh, and in a mud puddle in the road on the edge of the Essex marsh just up stream from the second Range Light. At the edges of salt marshes and along the river, where owing to the influx of fresh water the saline content was light, salt and fresh water mosquitoes were apparently breeding in the same pools.

Concerning the fresh water breeding perhaps the most noteworthy feature is the presence of numerous sink holes which form ideal *Anopheles* breeding places.

Life History of Salt Marsh Mosquito. In order to understand the mosquito problem on salt marshes, some knowledge of the life history of the salt marsh mosquito is necessary. The eggs are laid upon the salt marsh mud, and not, as with most species of mosquitoes, on the surface of the water. When covered with water they hatch, and in about a week, in warm weather, the adults are ready to fly. They then invade the uplands, often flying in large numbers for many miles. The salt marshes are covered periodically by high tides and irregularly by heavy rains.

Effects of the Tides. Generally speaking, the breeding of the salt marsh mosquito is much more affected by the tides than by rainfall. Under typical conditions the marshes are flooded once or twice a month at perigee and apogee, and definite broods of mosquitoes are produced once or twice a month in consequence and can be predicted in advance. This is the condition on marshes along streams emptying directly into the Sound, par-

ticularly at Saybrook; but on marshes along the river this condition is complicated by the rise and fall of the river due to local or more often upstream rainfall, so that it is impossible accurately to predict the time of flooding and the resulting appearance of mosquito broods. In fact, flooding at irregular intervals by fresh water is the normal condition on the up-river marshes, so that in dry seasons they probably breed sparingly if at all, and in wet seasons moderately but continuously. Above the railroad bridge the influence of tides on mosquito breeding grows less and at Essex and beyond it is negligible.

Mosquito Drainage. In order to prevent the breeding of the salt marsh mosquito it is only necessary to prevent flood water from standing on the marshes. This is generally accomplished by putting in a system of ditches which allows water to drain off within a few hours after the marsh is flooded by tides or rainfall. Such a system requires a good clear outlet and a main drainage course of dimensions suited to the size of the area.

A system of parallel ditches from 10 to 18 inches wide and from 24 to 36 inches deep should be cut at distances varying from 100 to 300 feet apart, at right angles to this main course.

Most of the marshes at Lyme and Saybrook have main drainage courses which can be used as a groundwork for ditching systems, although in some cases it will be necessary to modify or supplement them. There are also many old ditches which if cleaned can be incorporated as part of the new system.

Maintenance of Drainage Ditches. Deep straight-sided ditches such as are used for mosquito drainage will last almost indefinitely if they are kept open and in working order. They should be thoroughly cleaned every year, in the spring, and it is advisable to have them patrolled during the breeding season and any casual obstructions removed. Occasional breeding spots can also be treated when discovered. In all probability it will require two inspectors to do this patrol work and assist and supervise the annual cleaning operation. One inspector should be assigned to each town. The cost of such cleaning and inspection should not exceed \$1,000.00 per annum.

According to a recent law passed by the Legislature, towns are obliged to maintain such ditches if the plan and execution of the work are duly approved by the Director of the Agricultural Experiment Station.

Salt Hay. Formerly the marshes of Lyme and Saybrook were regarded as of more value than at present as sources of salt hay and were ditched frequently so as to allow tide water to drain off as this increases the hay yield and improves its quality. Some of the meadows are still ditched for this purpose but on many of them the ditches are no longer maintained.

This ditching of hay land operates to prevent mosquito breeding and there are few mosquitoes breeding on the areas so treated. On the other hand, ditching to eliminate mosquitoes improves the hay yield. If all marshes were ditched to increase the hay yield there would be few mosquitoes, or if all were ditched to prevent mosquito breeding there would be a vastly increased hay yield.

Map. The map submitted with this report shows all the salt marshes examined and most of them very accurately. A few dotted areas were mapped in roughly in the field as the base map did not cover them. This map shows the larger ditches and drainage channels and in some cases the proposed location of new main ditches, but it does not show the location of proposed small ditches as those can as well be laid out in the field and would scarcely show on the map owing to its reduced scale. Each area which forms a unit has been assigned a number which is placed upon the map. A description of the area will be found by reference to the same number in the notes. Those on the Saybrook side refer to that town and to Essex; those on the opposite side to Lyme and Old Lyme. A cross indicates a bad breeding place or point requiring special consideration. The charts of the U. S. Coast and Geodetic Survey were used as a base map.

CLASSIFICATION OF AREAS ACCORDING TO MOSQUITO-BREEDING CONDITIONS.

In order to bring out clearly the breeding conditions and relative importance of the different marsh areas they have been divided into five groups on the basis of their breeding character, and each group is colored differently on the map. It should be understood that this classification is not a permanent one, but on account of possible changes in the marsh may need revision in about three years.

Following is a description of these different groups:

A. Low sodden marshes, flooded at every perigee and apogee tide period, and at many intermediate ones. This water remains long enough for all mosquito larvae to complete their development. Such areas respond quickly to rainfall and may produce added broods because of it. Such marshes are almost constant mosquito breeders and yield little salt hay. They are colored blue on the accompanying map.

B. High tide grass breeding marshes. Marshes of this kind have large areas covered with certain grasses or sedges where water stands long enough twice each month, following perigee and apogee tides, for mosquitoes to develop. In other portions mosquito breeding may occur only at perigee tides. It is the areas of Class B that give rise to the immense broods which occur only once or twice in a season. In discussing the different areas of this type of marsh an attempt has been made to give an estimate of the percentage of the total area which remains water-covered long enough to breed mosquitoes. Hay yields on this type of meadow are apt to be small. Areas of this character are colored purple on the map.

C. Marshes covered with open or grassy pools in which mosquitoes breed abundantly. In this class of marsh the general surface may or may not be capable of breeding mosquitoes, so in the descriptions it is sometimes necessary to resort to other classifications in addition to this one. The hay yield may be good, but the broken character of the surface renders it difficult to cut. Marsh of this character is colored red on the accompanying map.

D. Marshes on which mosquitoes breed occasionally and scatteringly, either in grass or pools. Generally these are fair or good hay producers. They are colored green on the map.

E. Marshes which breed only casually or rarely and only in small amounts, generally in small pools along their inner edges, or perhaps in clogged ditches. Marshes of this type are generally either tidal or are high and well drained. The latter are valuable for salt hay, the former seldom so. This type of marsh is colored yellow on the map.

Estimate of Cost of Ditching and other Work Necessary to Eliminate Mosquito Breeding. One object of this survey was of course to arrive at the probable cost of treating the marshes

so as to prevent mosquito breeding. In preparing this estimate the following factors were considered for each area:

- Amount of old ditch to be cleaned;
- Footage of lateral 10" x 30" ditch to be excavated;
- Footage of secondary outlet, generally 2' x 3' ditches required;
- Footage of primary ditches of larger dimensions required;
- Amount of special work, such as building and enlarging culverts, erecting tide gates, bulkheads, etc.

The cost of each was then estimated, in the case of ditch digging by applying a footage rate; in the case of cleaning old ditches and doing other work by figuring roughly the amount of labor and materials required. The footage rate for 10" x 30" lateral ditches is taken as 2½ cents per foot; for 2' x 3' secondary ditching 5 cents per foot is used. For larger ditches special rates have been used and specified. Likewise special rates for the different fresh water areas have been made to meet their special conditions.

SUMMARY OF COSTS.

It should cost roughly \$19,000.00 to eliminate all the salt marsh and more important fresh water breeding areas in the region of this survey. But \$15,000.00 spent on the salt marshes should be sufficient for them, while \$2,000.00 spent on the important fresh water areas should suffice for all practical purposes. Total \$17,000.00.

Following is a summary of the amount of ditching and costs in round figures:

AREA SALT MARSHES.

Areas of Old Saybrook	1,375	acres
" Old Lyme	1,380	"
" Lyme	490	"
Total	3,245	"

DITCHING REQUIRED:

10 x 30-inch laterals	Old Saybrook	236,500	feet
" " "	Old Lyme	265,000	"
" " "	Lyme	10,000	"
	Total	511,500	"

2 x 3-foot secondary ditch	Old Saybrook	10,700 feet
" " " "	Old Lyme	200 "
	Total	10,900 "
Larger special ditches	Old Saybrook	3,100 "

COST:

Cleaning old ditches	Old Saybrook	\$ 400.00
" " " "	Old Lyme	250.00
Cutting lateral ditches	Old Saybrook	5,900.00
" " " "	Old Lyme	6,850.00
" " " "	Lyme	250.00
Digging of 2 x 3-foot ditches	Old Saybrook	550.00
" " " " "	Old Lyme	50.00
Special ditches	Old Saybrook	400.00
Cost of special work	Old Saybrook	550.00
" " " "	Old Lyme	700.00

Total cost for salt marshes \$15,900.00

By eliminating certain areas as mentioned in the notes this sum could be reduced to the neighborhood of \$15,000.00.

The rough estimate of the fresh water areas made under conditions mentioned above is:

Old Saybrook	\$1,200.00
Essex	900.00
Old Lyme	800.00
Total	\$2,900.00
Grand Total	\$18,800.00

NOTES ON TOWNSHIP OF OLD SAYBROOK.

INTRODUCTION.

In Old Saybrook Township the breeding areas have been divided into two classes, salt marsh and fresh water areas, and each is discussed separately. The salt marshes being the more important are discussed first.

SALT MARSHES.

The salt marshes may further be divided more or less naturally into six groups as follows:

Chalker Beach and Chapman's Point Marshes (Nos. 1-3 on map).

Oyster River Marshes (Nos. 3-7 on map).

Back River and Plum Bank Creek Marshes (Nos. 8-21 on map).

South Cove and Fenwick Point Marshes (Nos. 22-40 on map).

North Cove and Church House Marshes (Nos. 41-48 on map).

Marshes north of railroad line (Nos. 48-52 on map).

Of these groups, the first, third and fourth are the most important—not so much because of their proximity to the settled portion of the town as because of their breeding qualities. Marshes north of the railroad are both remote and largely non-breeding and therefore of comparatively little importance. The Oyster River and North Cove and Church House marshes are moderate breeders and close enough to the settled portions of the town to require consideration but excepting the marshes north of the railroad are less important than the others.

If there is only a limited sum of money available so that only a portion of the area can be treated, the above will serve as a guide to indicate the sections which can best be omitted.

DETAILED DESCRIPTION OF INDIVIDUAL SALT MARSH BREEDING AREAS.

The following points regarding individual breeding areas are taken up:

Location of Area. Each area is numbered and in some cases also named. These numbers and names also occur upon the map and afford a ready means of locating it.

Grade of Breeding. Expressed by letters from A to E, the significance of which has been explained on pages 149-50. In the case of grass breeding areas, a figure giving approximate percentage of the surface of the marsh capable of breeding mosquitoes is also given.

Size of Area. Given in acres and tenths of acres.

Vegetation and Value of Salt Hay. Brief description only.

Work Necessary to Eliminate Mosquito Breeding. Gives footage of ditching of various sizes required as well as other work necessary. The requirements for lateral ditch of 10" x 24"-30" dimensions are given in terms of the average distance apart these ditches should be placed. The common distances are 150 and 200 feet. They are expressed thus: 1/150, 1/200, etc.

Cost. This is figured in accord with the footage rates given on page 151.

DESCRIPTIONS.

Chalker Beach and Chapman's Point Marshes.

1. Class B, 40 per cent. breeding surface. Area, 23.3 acres (approximate). Hay very poor. The outlet of this marsh is a channel parallel to the beach and drains into area No. 2, but it is blocked by the roadway to Chalker Beach. A culvert should be placed under this road at a cost of perhaps \$100.00. A 1/200 ditch system should be constructed. Footage required, 4,850. Cost, \$121.25. With culvert, \$221.25.

2. Class B, with 25 per cent. breeding surface. Area, 93.3 acres. Hay poor, but cut to some extent. This marsh has a number of sodden cove-like areas where breeding is intensive. Most of these have ditches into them but they are badly blocked and should be reopened and a new 1/200 system dug. Footage required, 19,400. Cost, \$485.00.

3. Class B, with 85 per cent. breeding surface. Area, 4.5 acres, on which the hay is cut. This marsh is a particularly bad breeder because the main drain is largely choked and the outlet is almost entirely blocked by cottages. This main ditch should be opened (2 x 3 feet) and the outlet restored. Perhaps a 2-foot tile drain 50 feet across the beach would insure this outlet being kept open. Cost, about \$75.00. Lateral ditches, 1/150 feet, should also be cut. Amount of ditching required, 1,250. Cost, \$31.25. Total cost, cleaning, ditching and installing drain, \$106.25.

Oyster River Marsh.

4. Class B, 10 per cent. breeding surface. Chiefly at the lower end. Area, 13.6 acres. Hay mostly sedge, but is cut. A few old ditches running into odd corners should be opened and a 1/200 system of lateral ditches cut. Footage required, 6,300. Cost, \$157.50.

5. A Class D area of 6.5 acres. Upper end fresh, but marsh should be treated as a unit. It produces good black grass hay but is rapidly deteriorating owing to obstruction of ditches and will soon be breeding as a Class B area. The culvert under roadway should be enlarged to 3 feet in diameter and a tide gate installed. Probable cost, \$200.00. A 2-foot ditch should be dug through the center of this area and a 1/150 system of laterals cut. Footage, main ditch, 800; cost, \$40.00; laterals, 1,800; cost, \$45.00. Total cost, \$285.00.

6. Class B, 40 per cent. breeding surface, except at upper end near railroad where it is Class C west of creek and Class D east. Area, 45.4 acres. Formerly a good hay meadow but now largely sedge grass with many bare spots. Requires a 1/150 ditching system over whole marsh and the reopening of main ditches into various ends. Footage required, 13,200. Cost, \$330.00.

7. Class E, lower end, C, and a B area as indicated by X. Area, 42.1 acres (approximate). Salt marsh changing into fresh. Cat-tails and 3-square grass. Upper end probably a fresh water breeder but rather remote to be of much consequence. Tide gate where road crosses is in poor condition and needs repairing. If this marsh is entirely ditched a 1/200 system should be installed. Footage, 8,800. Cost, \$220.00. But 1,500 feet at lower end near railroad might answer all practical purposes and cost would be only \$37.50.

Back River and Plum Bank Creek Marshes.

8. Class B, along shores of island Class A. Fifty per cent. breeding surface in Class B portion. Area, 56.4 acres. Hay thin, mostly sedge grass. Requires a 1/150 ditching system. Footage, 16,300. Cost, \$407.50.

9. Class C. Area, 4.5 acres. Hay good but cannot be cut with machine on account of pools. Requires a 1/200 ditching system. Footage, 900. Cost, \$22.50.

10. Class B, 10 per cent. breeding surface. Area, 53.1 acres. Numerous sodden cove-like portions, some cut off by roadway. Hay fair in spots, mostly sedge grass. All old ditches should be reopened and culverts placed under roadway. Cost, \$25.00 more or less. Cut a 1/150 ditching system. Footage, 15,400. Cost, \$385.00. Total cost, \$410.00.

11. Class B, 10 per cent. breeding surface. Area, 17.8 acres. Hay very thin. An old roadway to island was made by throwing a dike across a branch of the creek. This should be cleared away and a bridge substituted to secure rapid draining of sodden areas up stream. It would be about a week's work for one man to clear away this old dike. Cost, \$10.00-\$15.00. Besides that a 1/150 system of ditches should be installed. Footage, 5,200. Cost, \$130.00. Total cost, \$145.00-\$150.00.

(See No. 17 for description of channel draining through this area.)

12. Class D. (Owing to influence of a few local ditches.) Area, 8.4 acres. It should be treated along with rest of marsh and a 1/150 system dug using old ditches where possible. Hay fair. Footage required, 2,400. Cost, \$60.00.

13. Class B, 20 per cent. breeding surface, upper end covered with cat-tail. Area, 6.5 acres. No hay to amount to anything. Open main drain, 2 x 3 feet, and cut 1/150 laterals. Footage required: main ditch, 1,000; laterals, 1,900. Cost: main ditch, \$50.00; laterals, \$47.50; total, \$97.50.

14. Class B, 25 per cent. breeding surface. Area, 20.1 acres. Hay very scant. Clean present ditches as indicated on map and add a 1/150 ditching system. Footage: cleaning, 900; new ditches, 5,800. Cost: cleaning, \$22.50; new ditches, \$145.00. Total, \$167.50.

15. Class E. Cat-tail marsh. Area less than 1 acre. Open main drainage course, length, 350 feet. Cost, \$8.75.

16. Class B, 50 per cent. breeding surface. Area, 16.2 acres. Open 2 x 3-foot channels into various cove-like areas as per map and add 1/150 system of lateral ditches. Footage: 2-foot channels, 2,000; laterals, 4,700. Cost: main channel, \$100.00; laterals, \$117.50. Total, \$217.50.

17. Class B (A along western edge), breeding surface 90 per cent. potential, probably never attains this figure or anything like it, as fish are apparently always present in some of the pools. Area, 71.3 acres. Hay largely valueless. So much water remains upon this area most of the time that it will be necessary to reopen the half obliterated channel east of the island through No. 11. This channel should be made at least 4 feet deep and 3 feet wide. The present channel should be cleaned and straightened and extended to the upper end of the marsh so as to connect with the various fresh water breeding areas draining into it. 2 x 3-foot ditches should also be dug into the various corners as shown on the map and a 1/200 system installed. Footage: new outlet, 1,300; extension of main ditch, 3,500; laterals, 12,700. Cost: new outlet, \$130.00; extension main ditch, \$175.00; laterals, \$317.50. Total, \$622.50.

18. Class B and C, 40 per cent. breeding surface. Area, 6.5 acres. One-third sedge grass hay. Requires 1/150 ditching system. Footage, 1,900. Cost, \$47.50.

19. Class B and C, 35 per cent. breeding surface. Area, 36.9 acres. No hay. Requires 1/150 ditching system. Footage, 10,700. Cost, \$267.50.

20. Class B and C, 50 per cent. breeding surface. Area, 33.0 acres. No hay. Ditching system, 1/200. Footage, 6,900. Cost, \$172.50.

21. Class B, 85 per cent. breeding surface. Area, 18.8 acres. No hay. Open new ditch 2 x 3 feet into corner as indicated by map and ditch 1/200. Footage: 2-foot ditch, 1,200; laterals, 4,000. Cost: 2-foot ditch, \$60.00; laterals, \$100.00. Total, \$160.00.

South Cove and Fenwick Point Marshes.

22. Class B, 20 per cent. breeding surface. Area, 13 acres. Hay fair. Clean upper ends of existing ditches and add a 1/150 system. Footage, 3,800. Cost, \$95.00.

23. Class A. Area, 6.5 acres. Hay of little or no value. Make extra outlet (2 x 3 feet) through neck of highland, which is only 1 foot above marsh level, as shown on map, and cut 1/100 laterals. Footage: new outlet, 670; laterals, 2,500. Cost: new outlet, \$35.00; laterals, \$62.50. Total, \$97.50.

24. Class B, A along inner edge. Forty per cent. breeding surface. Area, 3.2 acres. Hay fair. New ditches, 1/150. Footage required, 900. Cost, \$22.50.

MAP OF MOSQUITO BREEDING AREAS AT MOUTH OF THE CONNECTICUT RIVER.

By P.L. Buttrick, Special Agent.
Prepared Under the Direction of the
CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

New Haven, Connecticut.

August 1915.

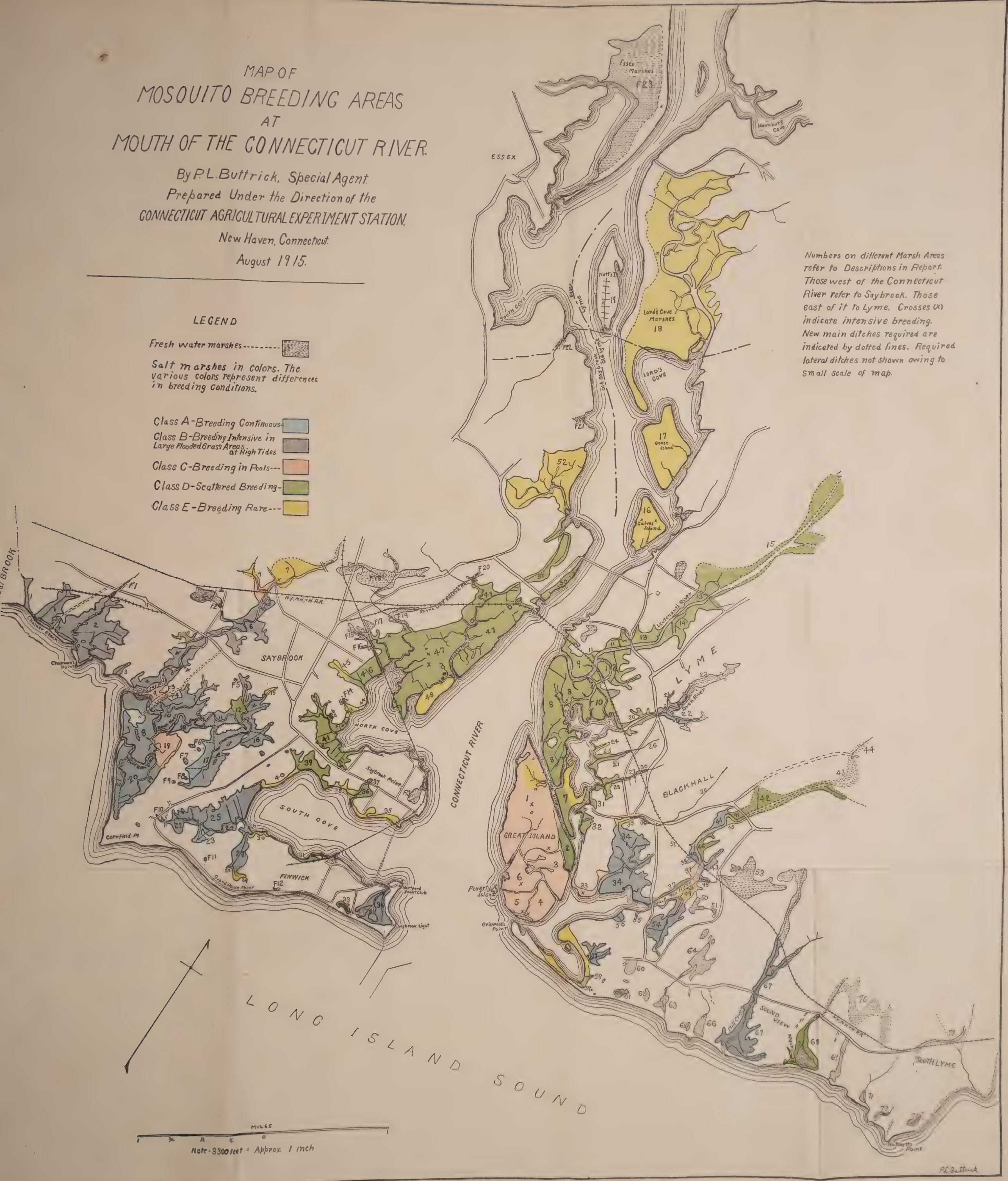
LEGEND

Fresh water marshes-----

Salt marshes in colors. The various colors represent differences in breeding conditions.

- Class A-Breeding Continuous
- Class B-Breeding Intensive in Large Flooded Grass Areas at High Tides
- Class C-Breeding in Pools---
- Class D-Scattered Breeding---
- Class E-Breeding Rare---

Numbers on different Marsh Areas refer to Descriptions in Report. Those west of the Connecticut River refer to Saybrook. Those east of it to Lyme. Crosses (x) indicate intensive breeding. New main ditches required are indicated by dotted lines. Required lateral ditches not shown owing to small scale of map.



25. Class B, 15 per cent. breeding. Area, 58.3 acres. Good hay meadow but beginning to deteriorate. Larger ditches in fair shape but smaller ones badly choked and need cleaning. New ditches required 1/200 system. Footage: old ditches to be cleaned, 2,800; new ditches, 12,000. Cost: cleaning old ditches, \$70.00; digging new ones, \$300.00. Total, \$370.00.

26. Class A. Area, 3.2 acres; no hay. Open main channel 2 x 3 feet, length 350 feet, and ditch 1/100. Footage, 1,300. Cost: main ditch, \$18.00; laterals, \$32.50. Total, \$50.50.

27. Class B, 20 per cent. breeding surface. Area, 14.9 acres. Hay light. Clean upper portion of main channel and ditch 1/150. Footage, 4,300. Cost, \$107.50.

28. Class A. Area less than 1 acre. No hay. Requires 1 main and 1 cross ditch. Footage, 500. Cost, \$12.50.

29. Class E. Area, 3.2 acres. Black grass hay. Clean main ditch, 1,000 feet. Cost, \$25.00.

30. Class E. Area 3.2 acres. No hay. Ditch 1/200, footage, 650. Cost, \$16.25.

31. Class D. Area, 3.9 acres. A little hay. Ditch 1/200, spaced closer toward eastern end. Footage, 800. Cost, \$20.00.

32. Class C. Area less than 1 acre. Hay good. Has ditching system which is badly clogged. If opened would be sufficient. Cost, \$10.00.

33. Smaller lagoon at Fenwick Point. Shores of this lagoon are a Class D salt marsh. Area, 1.9. Edges here should be cleaned up and the material thrown back upon the marsh which should then be ditched 1/100. Footage, 800. If it is decided to excavate this marsh sufficiently to add to the lagoon and use excavated material to fill in other portions so that marsh is entirely abolished a special estimate will have to be prepared.

The costs of ditching as laid out will be about \$20.00.

34. Fenwick Point marsh and larger lagoon. This is a Class B marsh with 50 per cent. breeding. Area, 25.3 acres. Hay of little value. Drain, 1/150. Footage, 7,300. Cost, \$182.50. Probably it will be necessary to lower outlet by removing rocks below bridge (a small job) and to install tide gates at that point. Measurements: Distance across bridge, 13 feet. Height from stream bed to bridge head, 6 feet. Depth of water at high tide, 4½ feet. Bottom sand and rock. Runway rock-faced, tight enough to support gate. The cost of such a gate would probably not exceed \$50.00, including deepening of channel below. A desirable way in which to treat this whole marsh would be to erect a sod dike around the lagoon and along the stream draining it, put in a tide gate as indicated and fill in the marsh with material from the channel the next time it is dredged. Total cost of ditching and tide gate, \$232.50.

35. Class E, but a single bad B area as indicated by X. Area, 8.4 acres. Hay in pockets is good but along shore is valueless. Ditches 1/300. Footage, 1,200. Cost, \$30.00.

36. Class B west of creek, D east. Area, 13 acres. Salt grass hay. Clean old ditches and add equal amount of new to connect with 37. Old ditches, 1,500; new ditches, 1,500. Cost: old ditches, \$37.50; new ditches, \$37.50. Total, \$75.00.

37. Class D, possibly B. Area, 1 acre. Hay fair. Clean ditches (400-feet) and open culvert. May be necessary to enlarge this culvert. Cost for cleaning ditches, \$10.00.

38. Class E. A few small B places. Area, 3.2 acres. Hay black grass. Ditch 1/250 but spaced according to necessity. Footage, 800. Cost, \$20.00.

39. Class D. Area, 17.5. Good hay. Ditch 1/200 where needed. Footage, 3,600. Cost, \$90.00.

40. Class E. Area, 7.1 acres. Hay doubtful. No treatment required beyond keeping ditches open.

North Cove and Church House Marshes.

41. Class D. Area, 51.2 acres. Salt and black grass hay. Upper end of many branches covered with cat-tails. This area has a good ditching system, but ditches should be thoroughly cleaned and opened, or in a few years marsh will be in bad shape. A marginal ditch should be dug around whole meadow to look after casual breeding along inner end and ditches to main creek should be dug into ends at a, b, c and d. Footage, old ditches to be cleaned, 7,000 more or less. New ditches, 10,000 more or less. Cost: cleaning old ditches, \$100.00; digging new ones, \$250.00. Total, \$350.00.

42. Class D. Area, 3.2 acres. Hay good. Requires ditching 1/150 and a marginal ditch. Footage, 1,000. Cost, \$25.00.

43. Class E. Area, 2.6 acres. To clean existing ditches is enough. Cost, \$10.00-\$15.00.

44. Class E. Area less than an acre. No treatment required.

45. Class E. Largely cat-tails, upper end potential fresh water and malarial breeder. Area, 3.2 acres. Open main channel 2 x 3 feet through 46 to cove. Footage, 1,200. Cost, \$60.00.

46. Class D. Area, 12.9 acres. Good hay. Marsh fairly well ditched, but new ones should be spaced between existing ones where distance exceeds 400 feet between them. Footage, 2,000, more or less. Cost, \$50.00.

47. Church House Lot. Class D, a few B or C areas as indicated by X. Otherwise breeding is casual. Area, 309 acres. Inner edge largely cat-tails and most of larger ditches are bordered by them or equivalent vegetation. Outer portions mostly black grass; other parts excellent salt grass.

By cleaning old ditches and cutting new ones where distance between present ones exceeds 400 feet, area could be made mosquito proof. Footage required, 2,500. Cost, \$62.50.

48. Island part of Church House Lot, Class E. Area, 19.4 acres. Mostly black grass hay. A 1/300 ditching system would drain a few potential breeding pools and improve the hay. Footage, 2,500. Cost, \$62.50.

Marshes North of Railroad Line.

49. Class D. Area, 29.8 acres. Mostly good black grass hay but there are a few bad breeding corners as indicated by Xs. The ditches in some of them are badly clogged and are breeding both *Culex* and *Anopheles*. These should be cleaned carefully and a new 1/200 system opened. Footage: old ditches, 2,000; new, 6,200. Cost: old ditches, \$20.00, new, \$155.00. Total, \$175.00.

50. Class D. Area, 12.9 acres. Distinctly a salt marsh but now breeding fresh water mosquitoes in clogged ditches. Hay, red salt grass. Open old ditches and ditch 1/200. Footage: old ditches, 1,600; new ditches, 2,600. Cost: old ditches, \$20.00; new ditches, \$65.00. Total cost, \$85.00.

51. Class D. Area, 32.4 acres. Lower end (north) brackish, upper end (south) practically fresh, breeds *Culex* and *Anopheles* and might easily become a plague spot although not now bad. Is classed as a salt marsh because of its vegetation. A main ditch 4 x 4 feet square and an outlet cut under Ferry Road to 49 would probably be sufficient. Footage of ditch required, 1,800. Cost, \$300.00, more or less. Cost of culvert under road, \$150.00, more or less. Total, \$450.00, more or less.

52. Class E. Area, 110.8 acres. Largely cat-tail (outer portion) and 3-square grass (inner) brackish, breeds both salt and fresh water mosquitoes. To render entirely safe a 1/200 ditching system required but as compared with other areas scarcely worth doing. Footage, 23,000. Cost, \$575.00.

FRESH WATER BREEDING AREAS.

Although no special attempt was made to study the fresh water breeding places of the town, enough were seen to warrant a brief description of them, together with a few general comments.

Malarial Breeding Places. Practically all fresh water breeding places examined are capable of breeding the *Anopheles* or malarial mosquito, and wherever sufficient search was made they were found breeding. That Saybrook (and the same is true of Lyme) does not suffer extensively from malaria is apparently due to the absence of the disease itself rather than to the absence of its hosts. Certainly the stage is set for an epidemic and should a sufficient number of cases become established the disease would probably speedily become widespread.

Advisability of Controlling Fresh Water Breeding Places.

As far as obtaining freedom from the mosquito nuisance is concerned little or nothing would be accomplished save here and there locally to do away with the fresh water breeding areas, although the menace of malaria would be eliminated. On the other hand, to abolish the salt marsh breeding areas and leave the fresh water ones untouched would practically abate the nuisance except in the immediate neighborhood of the fresh water areas but would do nothing to eliminate the danger of malaria.

In case funds are not forthcoming to do both, it is our opinion that some of the salt marshes up the river could be safely neglected and the money necessary to ditch them be spent instead on some of the large and more important fresh water areas near the village.

Kinds of Fresh Water Breeding Places. There are several kinds of fresh water breeding places in Saybrook: The inland ends of many of the salt marshes are often fresh or at least only faintly brackish. These are often cat-tail areas. They are generally not very serious breeders and can best be treated along with the salt marshes of which they are really a part.

Open Fresh Marshes. Many of these are covered with cat-tails, but are frequently bad breeding areas and produce many malarial mosquitoes. They must be ditched or otherwise treated.

Wooded Marshes. These are apt to breed mosquitoes only early in the season and are seldom of much importance—at least so long as the other areas are untreated.

Sink Holes. Sometimes these areas are swampy and sometimes are open pools or puddles. The latter are usually less troublesome. The best treatment of sink holes is to fill them. By the use of a team and a drag scraper such an operation is not expensive, and at a trifling expense an area capable of cultivation takes the place of a breeding hole. When filling is not practicable an outlet should be provided.

Edges of Sluggish Streams. These are sometimes bad breeding places for malarial mosquitoes but there seem to be few places of this kind in Saybrook.

Following is a brief description of some of the important fresh water breeding places west of the Connecticut River. The estimates of cost are very rough but should come within 30 per cent.

The total estimated cost of treating the fresh water breeding places is \$1,175.00, not including the Essex marsh.

DESCRIPTION OF INDIVIDUAL FRESH WATER BREEDING AREAS.

F 1. Open marsh, semi-permanent breeder. Open main drain into 2. Footage, 1,600. Cost, \$50.00, more or less.

F 2. Lily pond and open swamp, permanent breeder. Lower the outlet to pond so as to drain swamp. (Not an expensive job. Cost, perhaps, \$25.00.)

F 3. Fresh water pond hole, constant breeder on small scale. Open channel to salt marsh 50 feet away. Cost, perhaps, \$35.00.

F 4. Pond hole once connected with marsh at 10. Reopen ditch.

F 5. Two wooded sink holes each about 100 feet in diameter. Permanent or semi-permanent breeders. Fill to depth of 4 feet, moving earth from surrounding banks. Requires movement of 2,000 cubic yards of earth. The cost of moving with drag scraper would be about 10 cents per yard or about \$200.00.

F 6. Two wooded sink holes. Permanent or semi-permanent breeders. Their treatment would be rather expensive as it would be necessary either to cut off the timber and scrape earth into them, or else to cart it from a distance. A 25-foot bank lies between them and the salt marsh, calling for considerable excavating which would make it expensive to open an outlet. It would probably cost \$250.00.

F 7. Wooded sink hole, permanent or semi-permanent breeder. Open drain to salt marsh at 17, 100 feet away. Cost, \$25.00, more or less.

F 8. Pond hole semi-permanent breeder. Dig drain into salt marsh at 17, some 60 feet distant. Cost, \$15.00, more or less.

F 9. Pond hole, permanent or semi-permanent breeder. Place culvert under roadway to salt marsh at 17, some 25 feet distant. Cost, with 24-inch tile pipe, about \$40.00.

F 10. Swampy pool on both sides of Cornfield Point road. Place culvert under old roadway to drain portion east of highway and fill the west portion. Cost of both operations, perhaps, \$60.00.

F 11. Pond hole 100 x 50 feet and 3 feet deep. Breeds along edges and might be filled but unimportant till much other work is done.

F 12. Low lying grass area. Breeds only during very wet seasons. 150 feet of ditch, 12 x 18 inches through center parallel to road, and a culvert under road to beach would probably keep this area dry. Cost, probably \$15.00 to \$25.00.

F 13. Fresh water lagoon and cat-tail swamp at Saybrook Point. Area of swamp, 6.5 acres. Breeds whenever water stands in the cat-tails. It would be futile to ditch this area as it stands, since the water stands at the same level in the swamp as in the lagoon, but if an opening were made into the river so that the tide would rise and fall in the lagoon, then by ditching the marsh breeding could be checked. Footage of ditch required for marsh would be 1,300. Cost, at $2\frac{1}{2}$ cents per foot, \$19.50. The cost of placing culvert under railroad might be as high as \$100.00. A 4-foot tile drain would not be too big.

F 14. Small fresh water and cat-tail swamp. Requires 300 feet of main ditch and 100 feet cross ditch opening into a culvert draining into 43. Cost, \$40.00, or less.

F 15. Fresh water cat-tail swamp and shallow lagoon draining into 46, through ditch parallel with railroad. This is a large and intensive malarial breeding place and should have attention. The drainage ditch is rather badly choked and should be thoroughly cleaned. Two-foot drains should then be dug to each neck of marsh. Total footage, 2,500. Cost, \$125.00. Cleaning main ditch, \$25.00.

F 16. Open fresh marsh. Drainage badly choked. Open up drain to outlet from F 15. Length, 500 feet. Cost, \$15.00, more or less.

F 17. Fresh marsh, upper end wooded, lower end covered with cat-tail. Open up channel into creek in 47.

F 18. Large marsh back of railroad station at Saybrook Junction with growth of wood and cat-tail. In wet seasons it may breed mosquitoes enough to be dangerous and annoying; in an ordinary season it may give no trouble at all. The only remedy is to open up the main channels and add laterals if it becomes necessary. The main channels are about 6,000 feet long, and it might cost \$150.00 to clean and open them.

F 19. Small wooded marsh of little consequence.

F 20. Small pond edged with cat-tails and swamp. Clean up the edges.

F 21 and 22. Cat-tail swamps. Too small and remote to be of consequence.

F 23. Essex Marsh area, 155 acres. Vegetation, cat-tails and sedges of various kinds. At time of visit water stood over whole marsh and it was in condition to breed fresh water mosquitoes abundantly. However, in a dry season it probably would be much less dangerous. This marsh even at its worst is probably of little importance to Old Saybrook and Old Lyme. There would be no difficulty about draining it. A $1/200$ system should be sufficient. Footage, 32,000. Cost at $2\frac{1}{2}$ cents per foot, \$800.00.

Summary of Costs for Saybrook.

Area	1,373.5 acres
Cost of cleaning old ditches	\$ 405.00
Footage of lateral ditches, 236,500; cost	5,912.00
Footage, 2' x 3', secondary ditches, 10,720; cost	538.00
Footage, larger special ditches, 3,100; cost	430.00
Tide gates, culverts, etc.; cost	540.00
Total for salt marshes	\$7,825.00
Total for fresh marshes	1,175.00
Total for town of Old Saybrook	\$9,000.00
Essex Marshes	800.00
Total west of River	\$9,800.00

Average cost per acre for work on salt marshes is estimated at \$5.70.

NOTES ON TOWNSHIPS OF LYME AND OLD LYME.

The salt marshes of Lyme may be divided not altogether arbitrarily into the following groups:

Great Island, Nos. 1-6 inclusive.

Back River, Nos. 7-10 inclusive.

Lieutenant River, Nos. 11-15 inclusive.

Up-river marshes, Nos. 16-19 inclusive.

Duck River and Black Hall marsh, Nos. 20-32 inclusive.

Black Hall River marshes, Nos. 33-56 inclusive.

Shore marshes, Nos. 57-75 inclusive.

Of these groups the Great Island, Duck River and Black Hall, and Black Hall River marshes are the most important. The Lieutenant River and Back River marshes are of little importance despite their proximity to the settled portions of the town, owing to their character, while the up-river marshes are both remote and sparse-breeding. The shore marshes are some of them bad breeders but constitute a separate problem for the people of Sound View, South Lyme and the various shore resorts of the section, and east of the Mill Creek marsh the shore marshes might be safely disregarded as far as their effect on the village of Old Lyme is concerned.

The fresh water breeding areas of Lyme, excepting along the south shore, are chiefly at the upper ends of the salt marshes and

will largely be taken care of along with them. Along the south shore some of the old salt marshes which have become fresh require special treatment as has been mentioned under the detailed descriptions.

Although the notes for fresh and salt breeding areas are not separated in the summary, they are so far as possible tabulated under different headings.

Much of the introductory matter given for Saybrook (see page 152) also applies to Lyme.

DETAILED DESCRIPTION OF INDIVIDUAL BREEDING AREAS IN LYME AND OLD LYME TOWNSHIPS.

Great Island Marsh.

1. Class C except at Xs where moderate-sized B areas exist and near the north end where there is an E cat-tail area. Except on this area hay is red salt grass. Area, 171.1 acres. The creek branches much more than is shown on map, extending nearly to the lower islands, but is rather clogged with vegetation. It should be cleaned out and a 1/200 system installed with reference to it and to the shore. Footage, 35,590. Cost, \$889.75. The cost of cleaning out the creek can only be guessed at, but I should think it might cost \$200.00, more or less. Total cost, \$1,089.75.

2. Class D, a few small B spots. Area, 15.6 acres. Excellent black grass hay. Will not require more than 1/300 ditching spaced so as to drain individual breeding places. Footage, 2,750. Cost, \$68.75.

3. Class C. Good salt and black grass hay. Area, 46 acres. Ditch 1/200. Footage, 9,570. Cost, \$239.25.

4. Class C. Hay fair along lower end, excellent at upper end. Area, 33 acres. Requires ditching 1/200 average but rather closer at the lower end. Footage, 6,860. Cost, \$171.50.

5. Class C, except at X which is B. Area, 16.8 acres. Poor quality salt grass hay. Requires, 1/150 ditching system. Footage, 4,870. Cost, \$121.75.

6. Class C, except at X which is B, an acre or so of solid 95 per cent. breeding. Area, 36.9 acres. Upper end good black grass hay but of course many holes and small grass breeding depressions exist. Requires ditching 1/200. Footage, 7,670. Cost, \$191.75.

Note. The total area of Great Island is 319.4 acres and the estimated cost of ditching and other improvements is \$1,882.75.

Back River Marshes.

7. Nameless island, Class D. On east side of the island chiefly wild rice grows, on the west side black grass. Area, 29.8 acres. Western side requires ditching 1/200. Footage required, 3,100. Cost, \$77.50.

8. Class D, but scattering non-breeding areas. Chiefly cat-tail covered, rest hay grasses. Area, 135.4 acres. Requires 1/300 ditching. Footage, 19,630. Cost, \$490.75.

9. Class D. Black and salt grass hay. Area, 42.1 acres. Clean old ditches and add 1/200 new ones. Footage: old ditches, 700, more or less; new ditches, 8,760. Cost: cleaning old ditches, \$17.50; digging new ones, \$219.00. Total, \$236.50.

10. Class D, except the portion above railroad embankment which is B. Area, 48.8 acres. Black grass and cat-tails. Main channel in portion above railroad should be opened, length 200 feet, and made 2 x 3 feet and 200 feet of laterals dug. If it proves necessary a tide gate should be hung on the culvert under the railroad. Cost, \$25.00, more or less. The main marsh should be ditched 1/200 but by using present ditches the total amount can be reduced probably 30 per cent. Footage required, 7,100. Footage, 2 x 3-foot ditch, 200. Cost, at 5 cents per foot, \$10.00. Cost, lateral ditches, \$177.50. Total cost, \$187.50.

Lieutenant River Marsh.

11. Class D, possibly rarely breeds as a B area. Area, 9.7 acres. Good salt and black grass hay. Requires ditching 1/125. Footage, 3,200. Cost, \$80.00.

12. Class D. Area, 32.4 acres. About 40 per cent. of this area is covered with cat-tails which follow the creeks and ditches and cover most of the ends and pockets, thus preventing them from being bad breeders. Outside of this the vegetation is mostly of hay grasses. Channels should be opened into the various ends and ditches dug in spaces where distance between existing ditches exceeds 400 feet. Estimated footage of 2 x 3 ditch 200, of laterals 3,500, more or less. Cost, 2 x 3-foot ditch, \$10.00; laterals, \$87.50. Total, \$97.50.

13. Class D. Area, 16.2 acres. Hay good. Requires 1/200 ditching. Footage, 3,370. Cost, \$84.25.

14. Class D. Area, 32.4 acres. Partly cat-tails; rest good hay. Requires ditches into dead ends and 1/200 system. Footage, 6,740. Cost, \$168.50.

15. Class D, or possibly E. Upper Lieutenant River Marsh; lower end salt; upper brackish or perhaps entirely fresh. Vegetation mostly cat-tails and sedges of various kinds, the two being about equally divided. Approximate acreage, 162 acres. The lower end of this marsh is a typical Class D area. Above, where it is brackish or fresh it may breed fresh

water species more or less, but owing to its remoteness could possibly be neglected. To properly ditch this marsh would require a 1/200 system. Footage, 33,700. Cost, \$842.50. Probably one-third of this sum spent on the lower end would be sufficient.

Up-River Marshes.

16. Calves Island. Class E, with few B spots as indicated. Area, 44.1 acres. A typical salt marsh; vegetation mostly black grass. This area is probably seldom flooded. A 1/300 ditching system, spacing ditches so as to drain individual pools would be sufficient. Footage, 6,390. Cost, \$159.75.

17. Goose Island. Class E. Area, 88.8 acres. Mostly cat-tails except along eastern shore where it is an old black grass marsh, but is being rapidly overrun by cat-tails. This outer area might breed more or less but a system of 1/200 ditches extending 150 feet back from shore would be sufficient to drain it. Footage, 3,000. Cost, \$75.00.

18. Lord's Cove Marsh. Class E. Area, 492.5 acres. Lower end black grass and cat-tails; upper 3-square grass and cat-tails. The latter together with similar forms of vegetation cover more than 50 per cent. of the marsh and are increasing. They follow the hay ditches and small creeks and are constantly encroaching still further on the general surface of the marsh. Wherever possible hay is still collected and the yield is high. The general character of this area is a low, occasionally flooded meadow, yet even at its north end it is distinctly brackish in character. It is flooded only by heavy rains and freshets. Occasional depressions breed salt marsh mosquitoes in more or less abundance. The highest point of salt marsh breeding actually found was opposite the north end of Nott's Island, as shown by cross on map. In a dry season it would probably breed very few mosquitoes. The only treatment that this marsh requires is to clean some of the smaller ditches and to dig new ones here and there to drain individual breeding areas. Footage, 10,000. Cost, \$250.00. Very rough estimate.

19. Nott's Island. A reclaimed marsh used for hay farming. A few depressions near middle of lower half of the island are breeding salt marsh mosquitoes but in a dry season would probably not do so. A thorough cleaning of existing ditches and a new median ditch would not only render this area non-breeding but would improve its hay yield. Footage: old ditches needing cleaning 4,000; (rough approximation) new ditches, 1,000. Cost: cleaning old ditches, \$40.00; digging new ones, \$50.00. Total, \$90.00.

Duck River and Black Hall Marshes.

20. Lower Duck River Marsh. Class D. Area, 27.2 acres. Sedge grass hay, but is used. Clean existing ditches, particularly those running into the various ends, and ditch 1/200. Footage, 5,660. Cost, \$141.50.

21. Upper Duck River, Nos. 21, 22 and 23, Class B. Ten per cent. breeding surface. Area, 12.3 acres. Upper portion and edges brackish and

covered with cat-tail. Hay poor. Open creek for 200 feet toward upper end and clean culvert under roadway. Ditch 1/100. Footage, 5,120. A tide gate at the highway bridge may prove necessary here. A small fresh water lily pond drains immediately into this area. It is a potential malarial breeder on a considerable scale. The edges should be cleaned and the swamp at its upper end dug out. Cost: lily pond, \$100.00; main creek and culvert work, \$35.00; lateral ditches, \$128.00. Total, \$263.00. Tide gate, if necessary, \$50.00.

22. Class B, 10 per cent. breeding surface. Area, 7.8 acres. Upper end cat-tail and wooded swamp. Straighten main creek and ditch 1/100. Footage, 3,240. Total cost, \$81.00.

23. Fresh marsh. Three-square grass and some cat-tails. Area, 16.2 acres. Probably always contains a few breeding places but particularly bad at this time owing to rains and unsatisfactory condition of salt marsh below. Clean main creek at lower end. This means digging a 2 x 3-foot channel 1,000 feet long. Cut 1/200 laterals. Footage, 3,370. Cost, at 2½ cents per foot, \$84.25. Main creek, at 5 cents per foot, \$50.00. Total, \$134.25.

24. Class E. Area, 3.2 acres. Excellent black grass hay but ditch is almost blocked and if not cleaned area will deteriorate rapidly. Footage required, 250. Cost, \$10.00.

25. Down-stream portion, Class D; up-stream, B. Area, 9.1 acres. Hay is cut. Ditch 1/150. Footage, 2,640. Cost, \$66.00.

26. Well ditched fresh marsh now largely reclaimed; satisfactory so long as ditches are kept open.

27. Pond hole 200 feet long, 50 feet wide. Intensive breeder of both salt and fresh water species of mosquitoes. Open outlet to salt marsh at 25 to connect with ditching system there. Length required, 100 feet. Height of land between, 2 feet. Cost of 2' x 3' ditch, approximately, \$15.00.

28. Class D. Area, 9.1 acres. Hay good. Ditch 1/150. Footage, 2,640. Cost, \$66.00.

29. Fresh cat-tail marsh. Area, 1 acre. Potential malarial mosquito breeder of considerable size. Culvert under roadway at lower end too small. Cost of enlarging, perhaps \$100.00. Main channel needs cleaning, 300 feet; cost, \$15.00. Laterals, 1/150. Footage, 290. Cost, \$7.25. Total cost, \$122.25.

30. Upper end of 29 above railroad. In wet weather fresh water and malarial mosquito breeder. Requires main ditch and lateral ditch parallel to railroad embankment, with possible enlargement of culvert under railroad. Footage, 250 feet more or less. Cost of ditch work, \$10.00-\$15.00.

31. Class D. Area, 3.2 acres. Clean main ditch (length 200 feet) and ditch 1/150. Footage, 930. Cost: cleaning creek, \$10.00; lateral ditches, \$23.25. Total, \$33.25.

32. Class D. Area, 6.5 acres. Hay good. Ditch 1/150. Footage, 1,880. Cost, \$47.00.

Black Hall River Marshes.

33. Class C, with B area as indicated. Area, 14.3 acres. Yields good hay but could not be machine cut. Ditch, 1/150. Footage, 4,150. Cost, \$103.75.

34. Class B, with 50 per cent. breeding surface. Area, 89.4 acres. This is one of the worst breeding areas encountered in the whole survey; certainly the worst in Lyme, not so much because of the percentage of breeding surface as because it seems to breed regularly with every tide. In rainy seasons such as the present it probably breeds as a Class A area. Hay almost worthless. Many of the dead ends on the eastern side require 1/100 laterals as well as the cleaning of the central ditches into them. Some parts of the area will require only 1/200 ditching but the average will be 1/150. Footage, 25,930. Cost, \$648.25.

35. Class E. Area, 6.5 acres. Excellent hay. Well ditched and largely non-breeding but ditches should be cleaned.

36. Fresh marsh fed by sluggish stream. Area, 2.5 acres. Both marsh and stream are potential malarial breeders on a considerable scale. The ditching of the salt marsh at 34 and opening of main channel through swamp portion would go a long way toward quickening the current in the stream. The swamp should be ditched 1/150. Footage: main ditch, 350; laterals, 720. Cost: main ditch, at 5 cents, \$17.50; laterals, at 2½ cents per foot, \$18.00. Total, \$35.50.

37. Class D. Area, 5.8 acres. Hay fair. Ditch 1/150. Footage, 1,680. Cost, \$42.00.

38. Class A. Area, 1.3 acres. No hay. Open drainage ditch along railroad to Black Hall River at 39. Footage, 250, more or less. Cost, \$25.00. Laterals, 200 feet. Cost, \$5.00. Total cost, \$30.00.

39. Class C. Area, 6.5 acres. Hay crop fair, but the land is much cut up by pools. Ditch 1/150. Footage, 1,880. Cost, \$47.00.

40. Class B, 25 per cent. breeding surface. Area, 2.6 acres. Hay fair. Ditch 1/150. Footage, 750. Cost, \$18.75.

41. Down-stream, Class B, 25 per cent. breeding; up-stream, D. Area, 11.0 acres. Red top and black grass hay. Ditch, 1/180 including main ditch into pocket which runs back to highway. Footage, 2,520. Cost, \$63.00.

42. Class D. Area, 32.4 acres (approximate). The upper portion of this marsh is only slightly brackish and probably breeds fresh water as well as salt water mosquitoes. Owing to its remoteness the upper portion of this marsh could be neglected if funds for entire eradication measures

were not forthcoming. Ditch, 1/200. Footage (approximate), 6,740. Cost (roughly), \$168.50.

43. Open alder swamp and peat bog. Probably a bad malarial breeder but too remote to greatly affect settled portions of town. Open up course of main stream.

44. Red maple swamp. Probably a semi-permanent breeder. Too remote to be of especial consequence. Clean main channel into 42 and 43.

45. Class E. Area, 1.9 acres. Good non-breeding black grass marsh. No treatment needed at present.

46. Class D. Area, 9.1 acres. Fair hay. Ditch 1/200 spacing irregularly as required. Footage, 1,890. Cost, \$47.25.

47. Class B, 50 per cent. breeding surface. Area, 14.9 acres. Hay fair. Ditch 1/100. Footage, 6,200. Cost, \$155.00.

48. Class B, 25 per cent. breeding surface. Area, 1.9. acres. Open main ditch and ditch 1/100. Footage, 790. Cost, \$19.75.

49. Class C. Outer portion Class E. Area, 6.5 acres. Hay good. Ditch 1/150. Footage, 1,880. Cost, \$47.00.

50. Brush swamp, a casual fresh water and malarial breeder. Open outlet to salt marsh at 49. Partial overflow outlet already exists. Should be lowered at least 2 feet. Cost, \$15.00, more or less.

51. Pond hole. Potential malarial breeder on a large scale. A ditch about 150 feet long carries overflow into 50. If this ditch were lowered 8 feet it would probably entirely drain this area. Cost, \$50.00, more or less.

52. Pond hole. Willows along border. Potential and malarial breeder on considerable scale. Fill to depth of 3 feet and repair culvert under railroad to carry off flood water. Requires 3,000 cubic yards, more or less, of earth. Cost of moving earth, \$300.00, more or less.

53. Wooded marsh. Potential wet weather breeder but rather remote to be of much consequence. It might be advisable to spend \$25.00, more or less, to open up outlet in 48.

54. Class B, 10 per cent. breeding surface (average), but varies from 0 to 100. Upper end cat-tail covered and Class E in character. Area, 29.2 acres. Ditch 1/200 average, but would require special spacing in some cases. Footage, 6,100. Cost, \$152.50.

55. Class B, 90 per cent. breeding surface. Area, 1 acre. No hay grasses. Requires single main ditch, 2 x 3 feet, 130 feet long. Cost, at 5 cents per foot, is \$6.50.

56. Class B, 25 per cent. breeding surface. Area, 3.2 acres. No value for hay. Marginal and outlet ditch, 450 feet. Cost, \$11.25.

Shore Marshes.

57. Class B, 50 per cent. breeding surface. Area, 9.7 acres. Produced only a poor sedge grass. Has good primary ditching system which requires cleaning and addition of 1/150 lateral system. Footage, 2,800. Cost, \$70.00.

58. Class B, 50 per cent. breeding surface. Area, 1 acre. Hay, poor salt grass. Requires single main ditch 130 feet long. Cost, at 2½ cents per foot, \$3.25.

59. Class A. Area, 1 acre. No hay of any value. Requires 200 feet main ditch, at 2½ cents per foot, \$5.00.

Note. The Class E area around the edges of the cove into which 58 and 59 drain is mostly wild rice and tidal flat and may be safely disregarded.

60. Fresh water swamp hole without an outlet. Breeds in wet seasons, more or less. Treatment would be difficult and expensive.

61. Salt lagoon and marsh without outlet. Marsh is Class D. Area, 2.6 acres. Extreme tides break over the sand beach, fill lagoon and flood the swamp. Drainage only by seepage. Fortunately swamp stands about 3 inches above what appears to be normal level of lagoon so that a ditching system is possible. Central and 1/100 lateral ditches. Footage, 400. Cost, \$10.00.

62. Fresh water cat-tail swamp. Possibility of intensive breeding of both salt and fresh water species. An outlet might be opened to the Sound but it would be somewhat expensive to drain this area and it is doubtful whether the ditch could be kept open any length of time. The most satisfactory remedy would be to fill the swamp, but this also would be quite expensive. It might be better to watch it carefully for a season to determine fully its importance before doing anything with it.

63. Fresh water cat-tail swamp with small lagoon near lower end. It might prove a serious fresh water and malarial mosquito breeder. Two remedies suggest themselves: (1) to restore the old outlet which leads out at the eastern end, and (2) to dig out the bottom of the lagoon so as to lower the water level enough to drain the swamp. Either would be somewhat expensive and perhaps not worth while. It would take a special and careful engineering estimate to arrive at the cost of either method.

64. Wooded marsh, apparently never much of a breeder and probably can be safely disregarded.

65. Small fresh marsh probably of some local importance. Could be filled for \$100.00 or less. An outlet could also be opened to the Sound but difficulty would be experienced in keeping it open.

66. Fresh water lagoon near shore and wooded swamp in rear. Probably a fresh water breeding place of more than casual importance, but a difficult area to treat. An outlet and a tide gate would have to be constructed to drain it and it would also be necessary to place bulkheads on

each side of outlet channel in order to prevent tidal current from blocking this outlet. It would require a careful and special estimate to arrive at the cost of such measures. Probably it would be well to observe the area carefully over a full season in order to determine its importance.

67. Mill Creek Salt Marsh. Class B, 30 per cent. breeding surface. Area, 60.9 acres, below railroad tracks. Mostly sedge grass of little value for hay. The outlet of this marsh is at present blocked by a wide sand bar. It will be necessary first to remove this bar and second to construct bulkheads on each side of the channel where it passes through the beach to prevent it from again becoming blocked. These bulkheads should be about 100 feet long and constructed of piles and 2-inch plank. The cost of materials and labor would be about \$250.00. The cost of removing the bar at a very rough estimate would be \$300.00. The marsh itself should be ditched 1/150. Footage, 12,700. Cost, \$317.50. Total, \$867.50.

Note. The upper portion of 67 is a fresh and wooded marsh but is so remote as to be of almost no consequence and was not specifically examined.

68. Lagoon surrounded by a Class D salt marsh. Upper end is a cattail and 3-square grass marsh. Area of marsh, 19.4 acres. A tide gate in good working condition controls water in lagoon. A 1/200 ditching system should be installed with reference to the lagoon. Footage, 4,000. Cost, \$100.00.

69. Fresh water cat-tail marsh without outlet. Might breed extensively in a wet season. Is now partly filled and work should be continued.

70. Wooded marsh, casual breeder but of no very great importance.

71. Small marsh area of little importance.

72. Two fresh water lagoons. Might breed slightly along edges and in small marsh areas at upper ends.

73. Series of fresh water pools back of railroad track potential malarial breeders.

74. Small salt marsh along Four-Mile River above railroad track. Apparently of minor importance and not examined specifically.

Summary of Costs for Lyme.

Fresh water areas which were estimated separately . . .	\$800.00
Acreeage of salt and brackish marshes, Old Lyme	1,393.1
" " " " " Lyme	492.5
Total east of Connecticut River	<u>1,885.6</u>
Footage of lateral ditch required	275,000
" " larger " " 	200

Cost of cleaning old ditches	\$ 250.00
“ “ lateral ditches	6,850.00
“ “ larger ditches	50.00
“ “ special work	700.00
Total cost for salt marshes east of river	\$7,850.00
Cost for Old Lyme only	7,600.00
Total cost for all areas estimated east of river ..	\$8,650.00
Cost for Old Lyme township only	8,400.00

Note. Costs rounded to nearest \$50.00 for sake of convenience.

Average cost per acre for work on salt marshes in Old
Lyme township \$5.50

CHANGES IN THE VEGETATION OF SALT MARSHES RESULTING FROM DITCHING.

BY W. E. BRITTON, B. H. WALDEN AND P. L. BUTTRICK.

It has long been known that ditching a salt marsh induces a heavier growth of the salt grasses and sedges growing there, and that different kinds of grasses and sedges appear after the ditches are cut. For instance, a soggy, undrained marsh usually has large bare areas and the vegetation often consists of rush grass, *Spartina glabra* var. *pilosa*, dead men's fingers, *Salicornia herbacea*, and marsh rosemary, *Statice limonium* var. *carolinianum*—plants which are of no agricultural value. After draining the marshes, these plants are largely replaced by spike grass, *Distichlis maritima*, black grass, *Juncus gerardi*, and red salt grass, *Spartina patens* (*juncea*). These last-named plants are of considerable economic value and furnish the bulk of the salt hay.

Though these facts are more or less generally known, there seem to be few, if any, definite recorded experiments or observations bearing on the subject.

The object of the work described in this paper is to obtain records of such changes in vegetation, after ditching the salt marsh, and to establish practicable methods for conducting more extensive investigations on the subject, if the results are promising.

In October, 1912, two plots, each containing one-fourth of an acre, were laid out on the salt marsh in the town of East Haven, just east of Lighthouse Point—an area which had just been ditched to eliminate mosquito breeding. The two plots men-

tioned were on opposite sides of the marsh and were drained by the same main ditch. It is apparent that the amount of ditching required to remove the standing water—which is necessary in eliminating mosquito breeding—is not necessarily sufficient to produce the maximum growth of salt hay. In the sample plots described in this paper there were probably enough ditches to eliminate mosquito breeding but it was found later that the main ditch was not adequate to remove the water at all times. When this became clogged, the water stood upon the surface so that there was some mosquito breeding at times. Owing to this fact, the changes in the character of the vegetation are not as marked as might be the case in some other areas, but while they do not show such great changes as was expected, they are nevertheless quite favorable.

The plots were divided into ten-foot squares and the areas of the different kinds of vegetation were carefully plotted. Levels were taken at intervals of 20 feet to note the change, if any, due to drainage, in the elevation of the marsh surface. The corners of the plots were marked with chestnut stakes two inches square and four feet long. These were driven about three feet into the marsh. Bearings were taken in each case from a permanent rock on the highland so that the plots could be re-located in case the stakes were removed. These rocks also served as bench marks in making the levels.

PLOT No. 1.

This plot is on the South End Marsh near the highland east of the grove, 100 feet in the rear of a sand bar and about 200 feet from the Sound. The main ditch of the marsh is at a distance of 378 feet. Until lateral ditches were cut during the summer of 1912 this plot had probably not been adequately drained for many years.

The marsh was soggy, and the muck had an average depth of 1.95 feet. The underlying surface is sandy.

This plot was again mapped in the fall of 1915, three years after the first observations were made. The accompanying maps (figures 2 and 3) show the areas of the different kinds of vegetation in 1912 and in 1915, respectively.

The following table gives the areas in square feet of the different kinds of vegetation in 1912 and 1915:

Vegetation.	1912 sq. feet.	1915 sq. feet.	Increase or decrease sq. feet. per cent.	
Black grass.....	1839.38	1636.62	- 202.76	- 11.02
Spike grass.....	5615.50	3464.71	- 2150.79	- 38.3
Spike grass and red salt grass .	.....	3455.07	+ 3455.07	+ 100.
Red salt grass	217.21	466.87	+ 249.66	+ 114.9
Rush grass	1943.34	1186.79	- 756.55	- 38.9
Rush grass and spike .....	.....	346.46	+ 346.46	+ 100.
Highland vegetation.....	.....	259.48	+ 259.48	+ 100.
Dead grass area.....	557.36	.....	- 557.36	- 100.
Bare area.....	643.21	.....	- 643.21	- 100.

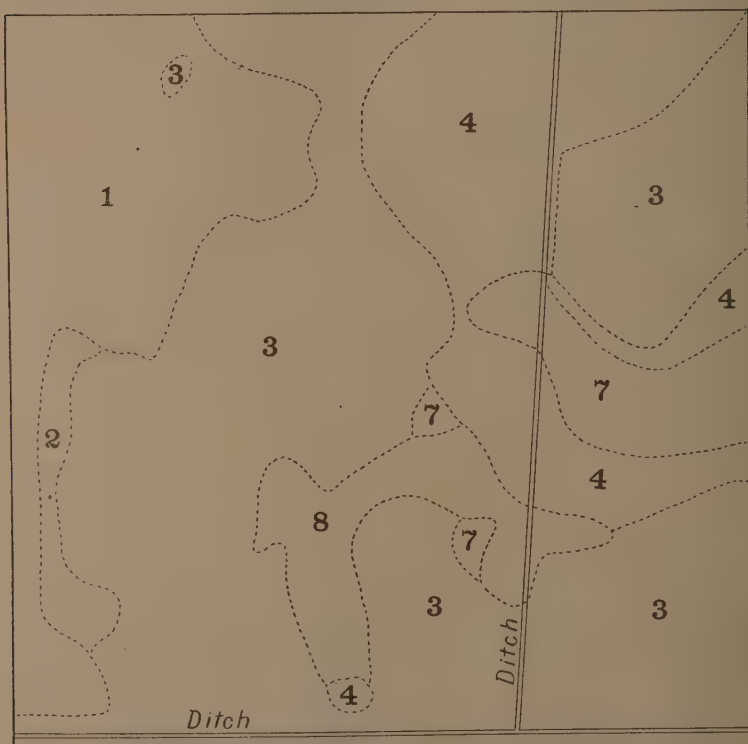


FIG. 2. Map or diagram of Plot No. 1, showing vegetation at time of ditching in 1912.

EXPLANATION OF MAPS.

- | | |
|-------------------------------|------------------------------|
| 1 Black grass | 5 Highland vegetation |
| 2 Red salt grass | 6 Salicornia |
| 3 Spike grass | 46 Rush grass and Salicornia |
| 23 Red salt and spike | 7 Dead grass area |
| 4 Rush grass | 8 Bare area |
| 43 Rush grass and spike grass | |

Black grass was the principal salt hay species present in 1912, the area being 1,839.38 square feet. In 1915 this had decreased to 1,636.62 (11.02 per cent.) due to the highland vegetation advancing on the west side and to the increase of red salt grass on the opposite side of the plot. Probably no further advance of highland vegetation will occur. In 1912 there was one area of red salt grass of 217.21 sq. ft. covering 2.01 per cent. of the whole plot. In 1915 there were two areas of red salt grass covering 466.87 sq. ft., or 4.31 per cent. of the area, making an increase

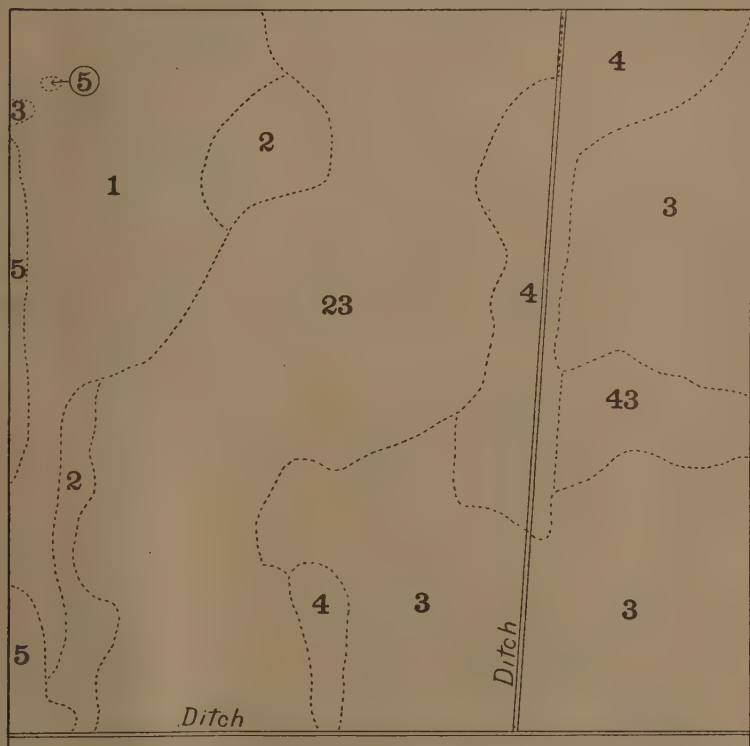


FIG. 3. Map of Plot No. 1, showing changes in vegetation three years after ditching, 1915.

in area of 114.9 per cent. This species is also advancing into the large spike grass area. It now averages nearly one-half the stand on 3,455.07 sq. ft., so that red salt grass is present on 36.26 per cent. of the whole plot, making its increase in area in proportion

to the size of the plot 34.25 per cent. The indications are that it will eventually replace most of the spike and rush grass areas. The spike grass is replacing the rush grass and has advanced over part of the dead grass and bare areas. The rush grass has covered the remaining portions of the dead grass and

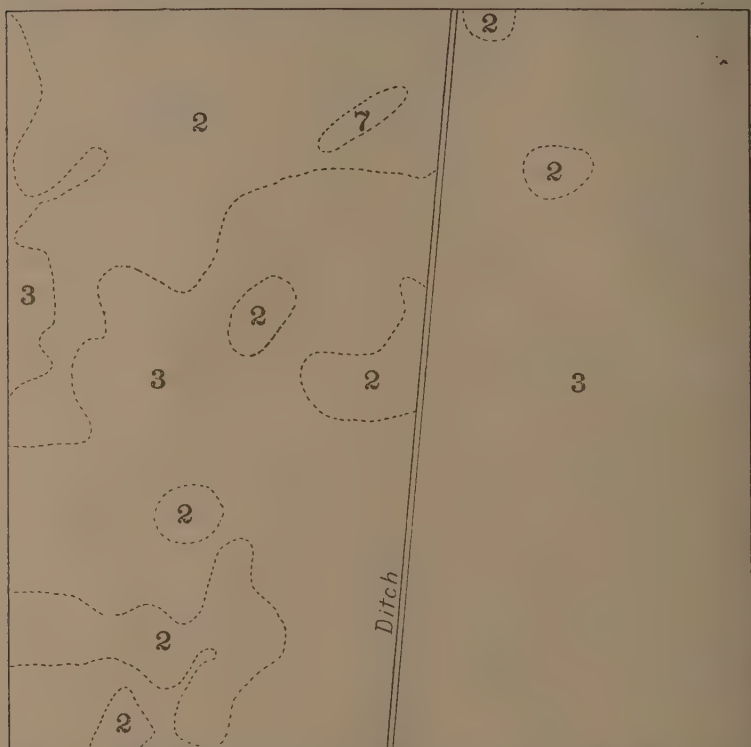


FIG. 4. Map of Plot No. 2, showing vegetation in 1912, at time of ditching.

EXPLANATION OF MAPS.

- | | |
|-------------------------------|------------------------------|
| 1 Black grass | 5 Highland vegetation |
| 2 Red salt grass | 6 Salicornia |
| 3 Spike grass | 46 Rush grass and Salicornia |
| 23 Red salt and spike | 7 Dead grass area |
| 4 Rush grass | 8 Bare area |
| 43 Rush grass and spike grass | |

bare areas but is being gradually replaced by the spike grass so that during the three years there has been a decrease in the rush grass area of 38.9 per cent.

The improvement in the character of the vegetation on this plot, while not as marked as it would be were the drainage more adequate, is nevertheless apparent. The bare and dead grass areas have been covered by rush and spike grass. The rush grass is being replaced by the spike grass, which in turn is being rapidly

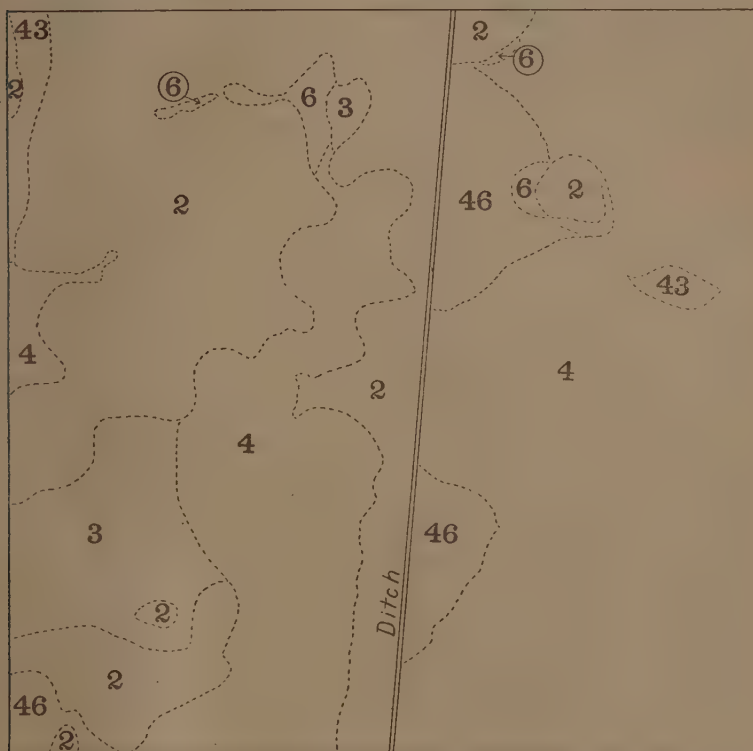


FIG. 5. Map of Plot No. 2, showing vegetation three years after ditching, 1915.

invaded by the red salt grass. The black grass, however, may be replaced by the red salt grass which seems to be the dominant species of the plot, and will probably in time cover it all. It is interesting to note that in three years, an area which was practically a bog hole has been turned by partial and insufficient drainage into a marsh of which the vegetation is heavy enough to warrant cutting for salt hay.

PLOT No. 2.

Plot No. 2 is located on the opposite side of the same marsh as No. 1. It is 54 feet from the highland and 27 feet from the main ditch. The average depth is 2.2 feet with a sandy bottom. Before drainage the surface was frequently flooded and the vegetation was rather scanty.

Figures 4 and 5 show the maps of the plots for 1912 and 1915 respectively, and the following table gives the areas covered by the different species of vegetation.

Vegetation.	1912 sq. feet.	1915 sq. feet.	Increase or decrease	
			sq. feet.	per cent.
Red salt grass.....	2852.03	3677.73	+ 825.70	+ 28.95
Spike grass.....	.....	655.93	+ 655.93	+100.
Rush grass.....	7911.56	5512.58	-2398.98	- 30.2
Rush grass and spike.....	.....	155.95	+ 155.95	+100.
Rush grass and <i>Salicornia</i>.....	.....	682.30	+ 682.30	+100.
<i>Salicornia</i>.....	.....	131.51	+ 131.51	+100.
Bare area.....	52.41	.....	- 52.41	-100.

The vegetation in 1912 consisted principally of red salt grass and rush grass, the latter quite thin and mixed with *Salicornia* and *Statice*.

In 1912 the red salt grass covered 2,852.03 square feet. In 1915 this had increased 825.70 square feet, or 28.95 per cent. Spike grass had come in, covering an area of 655.93 square feet, which was formerly occupied by rush grass. The vegetation had thickened considerably over the whole plot.

The improvement on this plot is less marked than on plot No. 1. This is due largely to the fact that the plot is located near the main ditch and towards its lower end where the water sets back sufficiently to keep the soil of the plot more or less water-soaked. Unless the main ditch is increased in cross section, this plot may never be entirely covered by red salt grass, which is the most desirable vegetation for it, but the improvement under partial drainage is substantial and significant.

These experiments show how rapidly changes take place in salt marsh vegetation following mosquito drainage, but the data are too incomplete to base any further conclusion than that these changes favor the more valuable hay grasses: and further that these grasses may take possession of even a poor marsh in a

few years after its drainage. We hope to continue these experiments by re-mapping these plots every few years, and possibly by laying out others on a larger scale under more favorable drainage conditions.

WHITE GRUB INJURY IN 1915.

In 1912 there was much damage from white grubs throughout the state, which was recorded in the report of this Station for 1912, page 288. As three years are required for the development from the egg to the adult stage, it was to be expected that 1915 would be a "white grub year," and such was the case.

On a four-acre experiment field at Greens Farms owned by Mr. E. T. Bedford, and managed by the Station, there was considerable damage. The grubs ate lettuce, mangels, corn, potatoes, and even onions were slightly injured. In a small patch of lettuce containing 15 rows, 100 feet long, or about 1,750 square feet, one of the men counted 1,800 white grubs, and he found 7 on one plant. This was on turf land which was plowed in the winter, probably after the grubs had descended deep into the ground to gain protection from the frosts.

At this office white grub injury was reported from Saugatuck; Greenwich, strawberries; Yalesville, potatoes; Meriden, potatoes, strawberry and various other plants; Wethersfield, corn; and from Southport, where one correspondent stated that half his potato crop had been ruined by the grubs.

At the Station farm at Mount Carmel most of the crops were on old ground and were free from damage.

In September, the writer was asked by Mr. W. A. Cook, County Agent of Hartford County, to visit a field in Wethersfield where corn had been seriously injured. The visit was made September 13 in company with Mr. Cook. The field was owned by Mr. Dudley Wells and was planted with a mixture of corn and soy beans for silage. The entire center of the field had been greatly injured. The plants were dwarfed and brown and dying. On pulling at the stalks most of them came up easily as the roots had been eaten off. There were many grubs in the soil, and innumerable holes where skunks had dug to get them. Most of the damage had been to the corn, yet in some cases they had also eaten off the roots of the soy beans as well. Illustrations of this injury appear on plates X and XI.

In order to give as complete a summary as possible of white grub injury, I have asked the seven county agricultural agents in the state regarding their records and the distribution of white grub damage. The reports follow:

Fairfield County, S. J. Wright, Agent, Norwalk.

"The white grub has been the most injurious during the past season in the southwestern towns of Fairfield County, particularly New Canaan, where they have attacked grass sod, corn and potatoes principally. From Stamford and Darien, I have had several reports of their work on potatoes, and from all towns have come a few reports of some injury to potatoes."

New Haven County, F. E. Rogers, Agent, New Haven.

"Injury from white grubs has been reported to me from the following towns:—Middlebury 1, Prospect 1, Orange 2, Meriden 2, North Branford 1, Milford 1. The numbers after the towns indicate the number of cases reported. In most cases corn has been the crop injured. Occasionally strawberries have been mentioned, together with meadows and pastures."

Middlesex County, John H. Fay, Agent, Middletown.

"We have no information regarding the white grub on file in our office, and in my travels I have not found any reports of serious injury."

New London County, F. C. Warner, Agent, Norwich.

"Norwichtown, Lebanon, Lisbon and Colchester all reported white grub injury the past summer to the potato crop, I should estimate a total of ten cases having been reported at the office throughout the season. I inspected several fields personally and found that the white grub had eaten potato tubers, causing considerable injury."

Litchfield County, A. W. Manchester, Agent, Litchfield.

"I regret to say that I have kept no exact record of the sources of inquiries regarding injuries from the attacks of white grubs. At one time during the summer, I communicated with you about the matter as there were a large number of inquiries at that time. At present I can only say in a general way that more of the questions came from New Milford than from any other town and injuries to corn roots, potatoes and strawberry plants were reported."

Hartford County, W. A. Cook, Agent, Windsor.

"The only serious grub attack that was brought to my attention during the past season was at Wethersfield, which you and I visited together."

Tolland County. No organization. No report.

Windham County, W. C. Kennedy, Agent, Putnam.

"I am glad to say that I have not observed any extensive injury from white grubs. There must have been some through parts of Windham County, but I have not yet come in touch with it."

White grubs are the larvae of the June beetles of the genus *Lachnosterna*, of which there are at least fifteen species in Connecticut. Of this number *L. fusca* Fröh., *L. fraterna* Harris, *L. hirticula* Knoch, *L. crenulata* Foerster, and *L. nova* Smith, are the most common and presumably are responsible for the damage. We have not reared the adults from any grubs actually found feeding on the roots of grass or cultivated crops.

White grubs may be expected to be again abundant in 1918 and farmers should plan accordingly.

CONTROL MEASURES.

Cultural practices should be followed to lessen white grub injury. Plowing and disk-harrowing in the fall will expose and kill many of the grubs. Crops most liable to be injured, such as corn, potatoes and strawberries, should not be placed on turf ground, weedy land, nor follow small grains, on years when white grubs are expected to be abundant.

ENTOMOLOGICAL FEATURES OF 1915.

The preceding winter was rather mild and not marked by any period of unusually low temperature. The spring and early summer of 1915 were rather cool and backward with little rainfall. Consequently many crops developed slowly. Heavy rains came late in July and were frequent during August and September, yet the total rainfall for the year was somewhat below the normal.

Tent caterpillars were even more abundant than in 1914, if it is possible for them to be more abundant.

Aphids of various kinds were common and abundant and caused considerable damage. The green apple aphid was present on the young trees at the Station Farm at Mount Carmel and required treatment, and the rosy apple aphid caused a portion of the fruit in the old orchard to be stunted and worthless. Certain other kinds of aphids were responsible for considerable injury of beet seed growing in Milford.

The San José Scale is now highly parasitized in Connecticut and is on the decline as an orchard pest, though spraying should still be persistently practiced against it.

The season of 1915 was remarkable for the great abundance of the apple maggot or railroad worm, which infested apples generally, especially the less acid and early ripening varieties; also the cabbage maggot was unusually abundant and caused great injury to early cabbages where no control measures were practiced.

Probably the chief entomological feature of 1915 was the discovery in Connecticut of the destructive European pine sawfly, *Diprion (Lophyrus) simile* Hartig, which is described on page 118 of this report. Though the larvae were first found in 1914, the identity of the species was not learned until May, 1915. Studies of this insect are being continued.

Another forest insect, the larch sawfly, was observed in Connecticut for the first time in 1915, and a full account may be found on page 125.

The summer was marked by an unusual amount of injury to grass and hoed crops by white grubs, the most since 1912. There were no signs of army worms noticed during the year and no reports were received of their presence within the state.

Red bug injury is apparently increasing in orchards, though the insects can scarcely be called abundant anywhere.

Progress has been made in suppressing the gypsy moth, no new infestations have been discovered in the state, and probably the pest has been eradicated in some of the twenty towns marked infested on the map. The spread of the brown-tail moth was very slight, only three new towns being found infested. Most of the nests were small and in many of them the larvae were dead.

There seems to be a slight subsidence in the amount of damage caused by the hickory bark beetle though many trees have died during the year.

There were a number of reports of serious damage to apple and peach trees by borers, so it seems as if 1915 might be called a "borer year."

It may not be out of place here to record also the discovery in the state of three scale insects, of two psyllids, the juniper web-worm, and a snout beetle from Europe not hitherto known to

occur here. These insects are all treated separately elsewhere in this report.

The summer of 1915 will long be remembered as one of the worst mosquito years of which we have record along the Connecticut coast. As most of these mosquitoes were the salt marsh species, their great abundance may perhaps be explained by the very high tides combined with heavy rains late in the season.

As a result many communities were aroused and in several towns preliminary measures were taken toward draining the worst mosquito-breeding areas. It is to be hoped that in each case the matter will be carried through so that some definite benefit will follow the advent of this "mosquito year" of 1915.

MISCELLANEOUS INSECT NOTES.

The Banded Flea-Beetle.—On July 7th specimens of the banded flea-beetle, *Systema taniata* Say, were brought to the office from North Haven where they were abundant and causing injury to beans, tomato, egg-plant and sunflower, by feeding upon

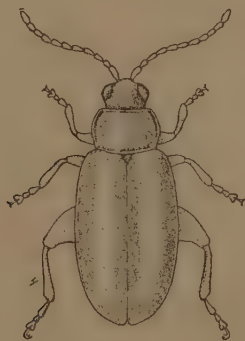


FIG. 6. The Banded Flea-Beetle *Systema taniata* Say, nine times enlarged.

the leaves. This beetle is about one-eighth of an inch in length, shining, and varies from pale brown to nearly black, marked longitudinally with white stripes, as shown in figure 6. Spraying with lead arsenate will prevent serious injury.

Unusual Galls on Wild Rose.—On August 27th specimens were received from Sharon containing leaves of rose (probably *Rosa carolina*) which bore curious fleshy galls with corrugated

margins. They are made by a cynipid or four-winged gall-fly, *Rhodites gracilis* Ashm., first described in Proceedings U. S. National Museum, Vol. XIX, page 135, 1896, and reprinted by Beutenmüller in Bulletin of the American Museum of Natural History, Vol. XXIII, page 645, 1907. Its habitat was given as "unknown," and this is the first Connecticut record for this species.

The Lime-Tree Span-Worm.—The caterpillar of this insect (shown on plate XV, d) was found by the writer feeding upon birch leaves in New Haven June 1st. Mr. Zappe collected the species in Derby from linden June 11th. Some of these larvae pupated June 15th and one adult was obtained in December. This is a native insect which also feeds upon the apple, and its scientific name is *Erannis tiliaria* Harris. Like the fall canker worm the females are wingless, and the eggs are laid in November and December. It is much less abundant than the canker worms though often found feeding with them. Spraying with arsenical poisons is the remedy.

Parasite of San José Scale.—In the report of this Station for 1913, page 254, was published a brief note regarding the subsidence of the San José Scale. Mention was made of finding material showing the exit holes of parasites, but at that time the parasites had not been obtained, and the species was unknown. Material was afterward submitted to Mr. Daniel G. Tower, who identified the work as that of *Prospaltella perniciosi* Tower. During the past season we have reared a large number of these parasites which are identical with the type material of the species mentioned above, which was described by Mr. Tower. This parasite is a very small, four-winged fly belonging to the family Chalcididae.

The Buffalo Tree Hopper.—The Buffalo tree hopper, *Ceresa bubalus* Fabr., is a rather common insect in Connecticut, yet it is rather unusual to find its characteristic injury on apple twigs. Such injury is much more common in some of the other states. On March 18, however, we received from Wethersfield some apple twigs which had been badly scarred by this tree hopper in laying its eggs. This twig and some of the insects are shown on plate XV, c and e. This insect cannot be overcome by the

usual sprays, but thorough cultivation, and the burning over of weedy borders in June, will help to control it. Cutting off and burning in autumn the twigs having the freshly-made egg-scars will also aid in its suppression.

Leaf Roller on Privet.—The leaf roller attacking privet hedges, which was studied by Mr. Walden in 1913,* was present on the Station grounds in 1915 and was once brought to the office from Willow Street, New Haven. The larva rolls the new growth, ties the leaves together with silk threads, and inside this nest it feeds. The adult is a small, olive brown moth bearing the Latin name of *Archips rosana* Linn. A full description and life history are published in the report of this Station mentioned below.

Apple Red Bugs.—The false apple red bug or lined red bug, *Lygidea mendax* Reuter, continues to do considerable damage in the southwestern corner of the state but is less abundant elsewhere. In both 1914 and 1915 this insect was present on the Station grounds and on June 2, 1915, a trace of its work was found by the writer in the apple orchard of W. A. Henry & Son, in Wallingford, though after hunting for an hour only one insect was found. On June 7th samples of its work were brought to the office from Cheshire. Where red bugs are prevalent, the trees should be sprayed just before the blossom buds open and again just after the petals fall, with Black Leaf 40, one pint in 50 gallons of water. This can be added to a mixture of lead arsenate and fungicides.

Sawfly on Imported Manetti Rose Stock.—For the past two years manetti rose stock from France has contained sawfly larvae in the pith of the stumps where the tops had been cut off. On rearing the adults it proved to be *Emphytus cinctus* Linn., a European species already established in this country. This insect apparently does not bore into the plants in any injurious manner but merely goes into the pith of the cut stems because this is a convenient place in which to pupate. Nearly all were within two inches of the cut end and naturally would be cut off in grafting

*B. H. Walden, Report Connecticut Agricultural Experiment Station, page 223, 1913.

or budding. They are shown on plate XIII, a. In Europe the larva feeds upon the leaves of rose and raspberry and is recognized as an injurious insect. The larvae can be killed by spraying the foliage with lead arsenate or hellebore.

The Linden Borer.—In one of the nurseries for several years there has been considerable injury to linden trees by the linden borer, *Saperda vestita* Say. The trees are attacked near the base, and large tunnels are cut under the bark. A fungus usually follows, causing the wood to decay and the trees soon break over. The injured trunks and the beetle causing the injury are shown on plate XIII, b. Apparently the life history of this beetle has not been carefully worked out, but as some of the other species require two years for their complete development we may expect the same to be true of the linden borer. All trees should be carefully examined at least twice each year, carbon disulphide injected into the burrows, and their openings tightly plugged to keep the fumes inside.

Two Psyllids New to Connecticut.—On May 29th some boxwood (*Buxus*) twigs were sent to the Station from Pomfret infested with nymphs and adults of a psyllid supposed to be *Psylla buxi* Linn. More material was later sent at our request. In order to make sure of the identity of the insect, specimens were sent to Dr. Edith M. Patch of Orono, Maine, who replied that *P. buxi* was present but that most of the psyllids were a different species which she had identified provisionally as *Spanioneura fonscolombii* Foerster. *Psylla buxi* was first recorded in the United States in 1884, and it has been reported many times since, though not from Connecticut. *Spanioneura fonscolombii* has not previously been reported from this country. Both are European insects and were probably brought to the United States on nursery stock.

Injury by the Strawberry Root Worm.—On August 21, some soil containing injured strawberry plants were received at the laboratory from a private garden in the western part of the city of New Haven. The leaves were riddled with holes, and in the soil were many adult beetles of the species commonly known as the strawberry root worm, *Typophorus canellus* Fabr. The writer visited the garden August 27th and examined the plants.

Nearly all leaves had been badly eaten, but the roots had not been injured. The beetles feed upon the leaves in May and the larvae live in the soil and eat the roots, becoming mature in July. They pupate in earthen cells from which the adult beetles emerge during August. They feed upon the leaves for a time, then go into winter quarters. There is but one brood each season. A thorough spraying with lead arsenate when the beetles begin to feed in May and August will probably prevent serious damage.

A Woolly Aphis on Silver Maple.—In June there was brought to the Station, from Derby, a branch of cut-leaved silver maple, containing a mass of woolly aphids shown on plate XVI, d. This insect was formerly known as *Pemphigus acerifolii* Riley but in the recent studies of Dr. Edith M. Patch* at Orono, Maine, it is shown to be identical with the so-called alder blight, *Pemphigus tessellata* Fitch. The tree in question was sprayed in the morning with kerosene emulsion, and when examined by the writer in the afternoon, all aphids had been killed which were hit by the spray. A few twigs remained unsprayed and the gardener was instructed to either cut them off or treat them with the emulsion.

White Ants in House at Ridgefield.—On May 12, 1915, specimens of white ants, probably *Leucotermes* (*Termes*) *flavipes* Kollar, were received from Ridgefield, where they had tunneled in the structural timbers of a dwelling house, eating their way out into the kitchen where they emerged in large numbers. These insects are quite common and swarm at about this time of the year. A few years ago they emerged from the board walks in the Station greenhouse, and once the writer noticed them swarming from the boards along the edges of the tar walks on the New Haven Green. They also breed in old stumps in fields and woodlands. Occasionally they cause considerable damage to buildings, bridges, trestles, etc., by tunneling in the timbers, greatly weakening the structure. If it is known that they are present, it is a simple matter to kill them by boring into the infested posts or beams, injecting some carbon disulphide and plugging the opening.

* Edith M. Patch, Journal of Economic Entomology, Vol. 2, page 35, 1909.

The Chrysanthemum Leaf Miner or Marguerite Fly.—Plants of the family Compositæ, and especially chrysanthemums and marguerite daisies growing under glass, are occasionally attacked and disfigured by this insect, *Phytomyza chrysanthemi* Kow. Thus samples of infested marguerites were received from Milford, April 8, 1911, and from New Canaan December 17, 1915. The larva tunnels in the leaf, eating out the green tissue and leaving only the veins and epidermal layers. Where thus eaten, the leaves have a whitish appearance as shown on plate XVI, a. Both larval and pupal stages are passed in the tunnels. The most comprehensive account of this insect which has been published occurs in a bulletin of the Massachusetts Station* and this publication recommends as a control measure spraying with the nicotine solutions, such as Black Leaf 40, diluted at the rate of one part in about 400 parts of water, and applied at intervals of about twelve days.

A New Leaf Weevil in Connecticut.—On May 24, 1914, the writer collected in his own garden some small, bright green snout beetles. They seemed to be in the grass of the lawn under a birch tree and would crawl over one's clothes. Other specimens were taken on June 12 and 30, 1915, in the same locality. The species was identified as *Polydrusus impressifrons* Gyll. from Europe, by Mr. W. Dwight Pierce of the Bureau of Entomology, of Washington, D. C. The writer has not made any observations upon its food habits or life history, and apparently little has been published in Europe regarding it. In a paper recently read before the Ontario Entomological Society by P. J. Parrott and Hugh Glasgow of the New York Agricultural Experiment Station, Geneva, N. Y., it was stated that this weevil was first noticed in New York at Geneva in 1906, and that it is now exceedingly abundant in some localities. It feeds upon unfolding buds and later upon the margins of leaves, especially of willow, poplar and birch. The larvae feed upon the roots. At present this insect is regarded as a minor pest in New York State, particularly in nurseries, though it can doubtless be controlled by spraying with lead arsenate.

* M. T. Smulyan, Mass. Agr. Expt. Station, Bull. 157, 1914.

A Tortricid on Oak.—On May 22d, small caterpillars feeding on oak were received from Mr. G. H. Hollister, Superintendent of Keney Park, Hartford, who wrote as follows:

"I am sending a package containing oak twigs which are infested with some insect which is doing considerable damage in the woods in the northern part of the park. I found it on four species of the black oak type, but none were on white oak. It had apparently commenced work soon after the leaves were out on some trees. I shall not attempt spraying the trees this year, but probably shall next year."

We did not recognize the caterpillars, which were small, greenish and semi-transparent, but the adults emerged on June 15, and proved to be *Tortrix albicomana* Clemens, a species which has long been known to feed upon oak. It has also been recorded upon rose and *Aquilegia canadensis*. The adult is a small moth having a wing-spread of five-eighths of an inch. The fore wings are sulphur yellow and the rear wings silver gray. Spraying with lead arsenate soon after the leaves unfold will probably prevent any serious injury.

The Iris Borer.—Several times during the past few years the writer's attention has been attracted to a larva boring in the rootstocks of German iris in gardens. Infested rootstocks were received from New Haven, June 30, 1906; July 23, 1909; July 6, 1910; July 5, 1913, and from Danbury July 29, 1915. In 1906, larvae were sent to the Bureau of Entomology at Washington, and thought to be *Macronoctua onusta* Grote. A brief note was published* regarding it. In all cases the material has been very meager and we did not succeed in rearing the adult, which is of course necessary for a definite identification.

From the material received this year from Danbury, an ortalid fly emerged but may not have been connected in any way with the borer. On July 29, Mr. Lowry collected on the Station grounds some infested rootstocks and from them, on October 4th, there emerged an adult of *Macronoctua onusta* Grote, which is shown on plate XV, b. This insect is apparently not very abundant but will be found here and there wherever iris is grown. The only control measure that can be recommended is to destroy the infested rootstocks as found when resetting the plants.

* Report Conn. Agr. Expt. Station, page 306, 1906.

Mites Injuring Bermuda Lilies.—On March 27, 1915, Easter lilies were sent to the Station by a local florist who had imported the bulbs from Japan in the summer of 1914. The plants were nearly ready to blossom when they began to droop and could not be made to recover. They were found to be infested with the Bermuda lily mite, *Rhizoglyphus hyacinthi* Boisdv., many of which were burrowing in the roots and main stem as shown on plate XIV. I am indebted to the Bureau of Entomology for the positive identification of this pest. Many of the roots were entirely dead; others were only partially killed, and a new set of roots had started out from the main stem above the bulb, which, of course, is abnormal. When plants reach this condition, they cannot be saved. Over 3,000 plants had thus been ruined.

The mites were probably on the bulbs when imported and perhaps might have been killed by dipping the bulbs in fir tree oil or a nicotine solution. At present there is no systematic inspection of bulbs imported into Connecticut, and florists should order bulbs on condition that they are not infested.

A New Enemy of Peach Trees.—On July 3d, we received from Mr. George A. Hopson of Wallingford, some small beetles causing injury in the orchard of a peach grower, with the following statement:

"I am enclosing a sample of insect which has wrought havoc in a peach orchard here by eating the green leaf buds as the leaves are beginning to start on newly-set trees. They seem to come up out of the ground about dusk and, before daylight have crawled into the ground or under stones near the base of the trees. They completely cleaned about 1,000 trees. Are they something new or am I behind the times? A letter from you would greatly please the owner who is an Italian; says he has dug as many as 40 from one tree."

The beetles in question were *Diplotaxis atlantis* Fall, and look like small June beetles, to which they are in fact closely related. An adult is shown on plate XV, a. Ordinarily they feed upon the leaves of native trees in the woodlands. It is a native species and is not supposed to do much damage to cultivated trees or plants. It is possible that the peach orchard was near a woodland where the beetles have been abundant. The writer learned that the beetles entirely disappeared soon after the samples were sent, so there was no opportunity for experiment. This record of injury is interesting and is mentioned here to show that frequently our

native species may, when abundant, attack and injure cultivated trees and plants, when under ordinary conditions they are not regarded as injurious. Possibly a heavy coating of lead arsenate on the buds and unfolding leaves might serve to check the pest and prevent further or serious injury.

Aphids on Seed Beets.—The writer was called to examine a field of beets grown for seed in the town of Milford on July 19th. This field was owned by The Everett B. Clark Seed Company and contained several acres. Most of the plants had blossomed and were loaded with the immature seed. The plants generally were infested with three species of aphids, some so badly as to ruin the seed crop. On account of this infestation some plants would produce only worthless seed, but by far the greater part of them would produce a crop of seeds which would be of light weight and therefore greatly inferior to the full-sized and heavy seed.

The most abundant aphid, and therefore the one chiefly responsible for the damage, is common on beans, dock and various native and cultivated plants. It is brown or nearly black and is commonly called the bean plant-louse, *Aphis rumicis* Linn. The other two are both more slender, light-green species which have been positively identified by Dr. Patch as *Macrosiphum solanifolii* Ashm. and *Myzus persicae* Sulz. The former is found on a number of cultivated plants and weeds, especially potatoes, and the latter is the green aphid of peach trees.

Lady beetles of several species were abundant over the field and many of the lice had been parasitized by *Lysiphlebus*, and their empty shells were still adhering to the leaves.

Both kinds of aphids were also found on the weeds, lambs' quarters, *Chenopodium album*, and pigweed, *Amarantus retroflexus*, which were growing throughout the field.

At the time of the visit, the damage had all been done and it was too late for any kind of treatment. It is probable that thoroughly spraying the plants with a nicotine solution like Black Leaf 40, applied under high pressure (one-half pint in 50 gallons of water, with 2 lbs. of soap) two or three weeks earlier in the season would have killed most of the aphids, saved the entire crop and proved a profitable investment. Mr. Clark was advised to try this treatment in a small way and watch results.

SENDING INSECTS FOR IDENTIFICATION.

In writing to the State Entomologist or to the Station regarding insect injuries, specimens of the insects or of their work should be sent, if possible, because such specimens form the basis of definite advice, whereas without them only general recommendations can be made to the correspondent.

Many insect specimens are received and identified each year, and if injurious, treatment is advised. This service must be of considerable value to the farmers, gardeners and orchardists of the State. It has resulted in the discovery of several insects not previously known to occur in the State, and has therefore been of value to this office as well as to the correspondents.

Except for rearing, the specimens should be killed before sending. This can be done by placing them in an oven for a few moments, suitably enclosed in a metalbox; also by immersing them in gasoline or alcohol, both of these liquids soon evaporating on exposure to the air. Insects may also be killed by a few drops of chloroform, or carbon disulphide placed with the specimen in a gas-tight box. The entomologist employs cyanide tubes and jars for killing insects when they are to be preserved for the collection; sometimes chloroform is used for moths which are too large for the cyanide jar.

There is a State law (see page 111, Sec. 3), providing a heavy penalty for transporting living gipsy or brown-tail moths in any of their stages from the infested region to a region not hitherto infested, so that all insects suspected of being either of these pests should be killed before sending. A Federal law also imposes a heavy penalty for thus distributing important pests through the mails.

Never send any insects loose in an envelope or folded in the letter, where they are usually crushed beyond recognition, often rendering the accompanying letter illegible. Place them in a strong box or mailing case; it is not necessary to punch holes in it. If insects are alive, and in the feeding stage, a bit of the food plant should be enclosed. Give what data you possess about the specimen. Above all, do not forget to place your *name and address* on the package. Several specimens are received each year with no indication who sent them, and the sender is probably still wondering why he did not receive a reply.



a. Infestation No. 5, Hampton, 1914; 40 egg-clusters were found in the stone-wall, and in the old apple-tree which has since been cut.



b. Woodland infestation (A), Thompson, 1914, after cleaning. One egg-cluster was found here.



a. Infestation No. 1, Putnam, 1915, after cleaning.
Seven egg-clusters were found.



b. Roadside apple-tree at infestation No. 8, Killingly. Tree shows tanglefoot band, warning notice, and triangular stickers informing general foreman where men may be found.

a. Spraying woodland trees in Thompson.



b. Spraying large apple-tree. Infestation No. 12,
Putnam.



GIPSY MOTH WORK.

PLATE IV.



a. Larvæ and pupæ of the larch sawfly. Natural size.



b. High-power sprayer used in woodland infestations.

LARCH SAWFLY AND GIPSY MOTH WORK.



a. Grove of larch trees in Woodstock, partially stripped by larvæ.



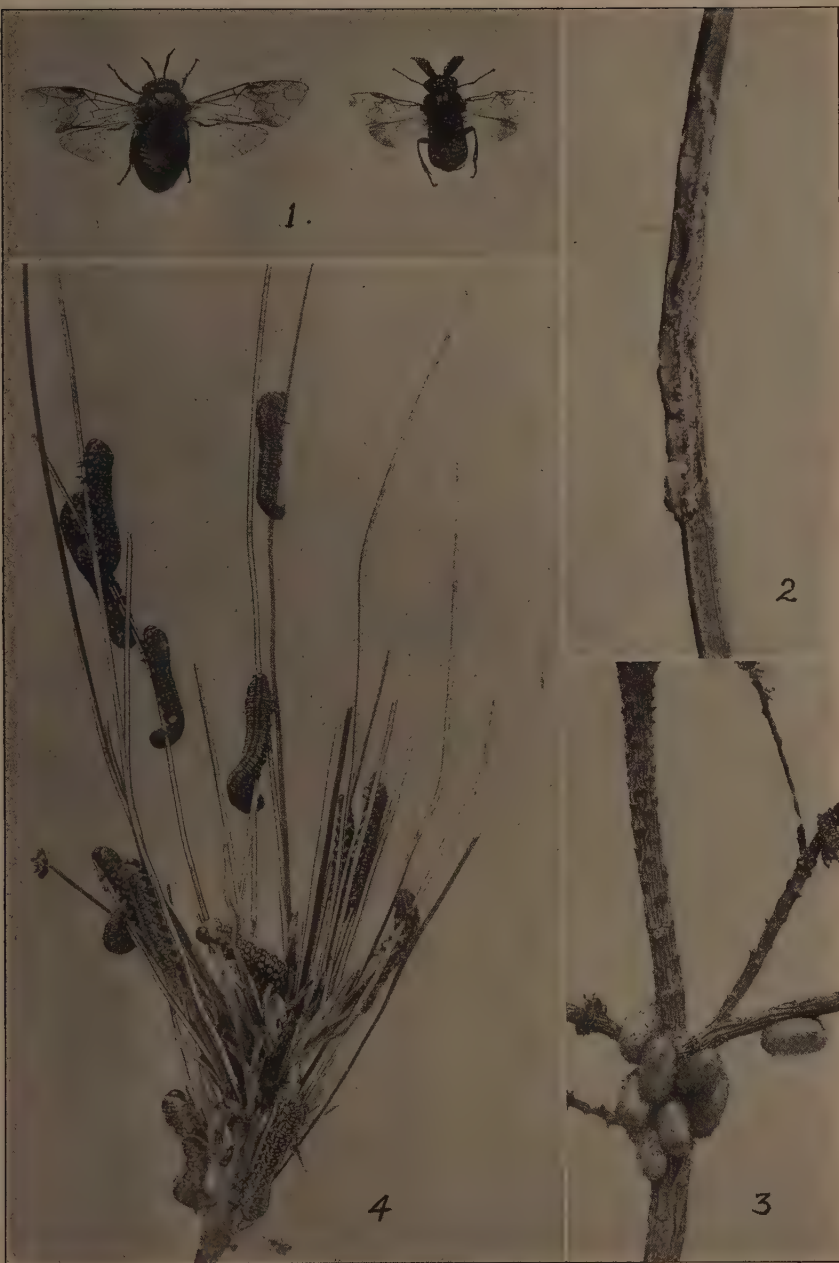
b. The two larch trees between pines were entirely defoliated. Canaan.



a. General view of experiment field at Mt. Carmel.

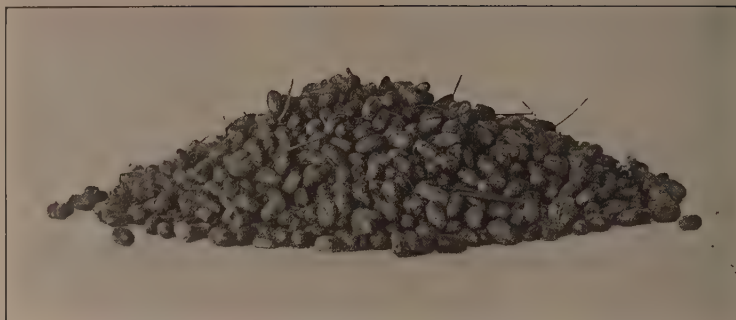


b. Plants at left were protected by tarred paper disks, 5 per cent. infested. Plants at right untreated, one-third ruined.

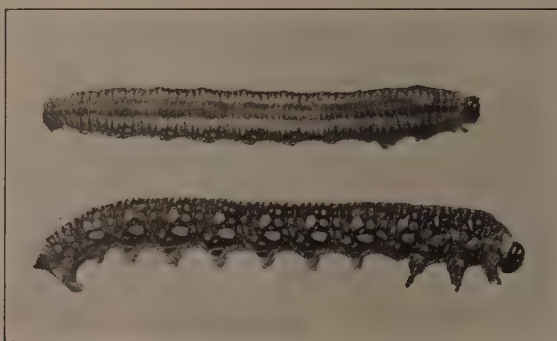


Diprion simile: Hartig. 1. Adults, twice natural size; 2. Eggs in pine needle, about 4 times enlarged; 3. Cocoons, natural size; 4. Larvæ feeding on pine, natural size.

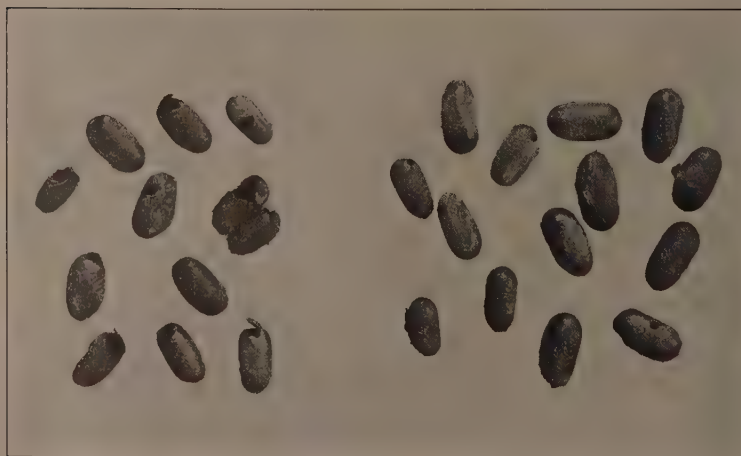
IMPORTED PINE SAWFLY.



a. A heap containing 1,617 cocoons, collected from pine twigs.



b. Dorsal and lateral view of larva, twice enlarged.



c. Cocoons at left have been torn open, probably by birds; those at right show exit holes of Chalcid parasite. Natural size.

a. Japanese or Bhotan pine. *Pinus excelsa*,
partially stripped by larvæ.



b. *Pinus cembra* about 7 feet tall almost
defoliated by larvæ.



IMPORTED PINE SAWFLY.





White grub and corn plant with roots eaten. Natural size.

THE WHITE GRUB.



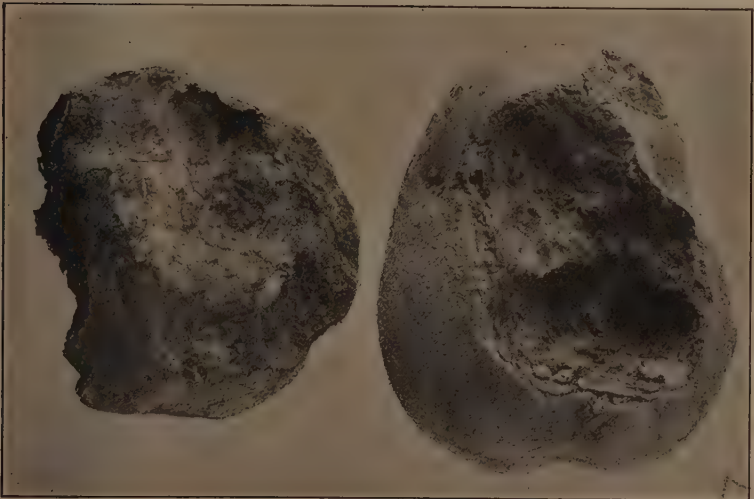
a. Soy bean (at left) and corn plants with roots eaten off by white grubs.



b. White grub.
Natural size.

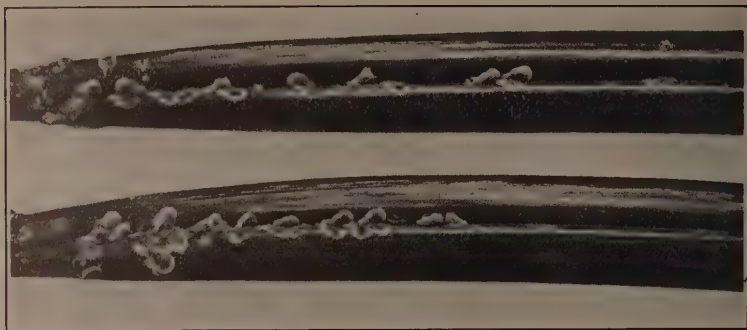


c. Adult June
beetle. Natural
size.



d. Potatoes eaten by white grubs.

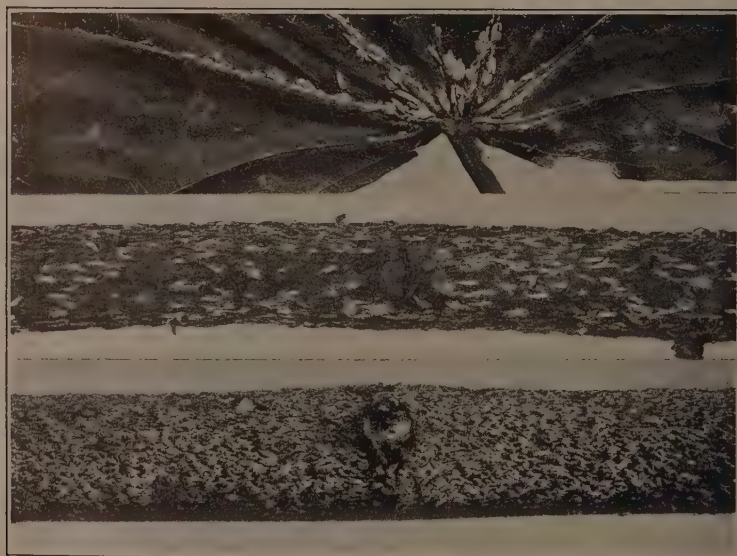
THE WHITE GRUB.



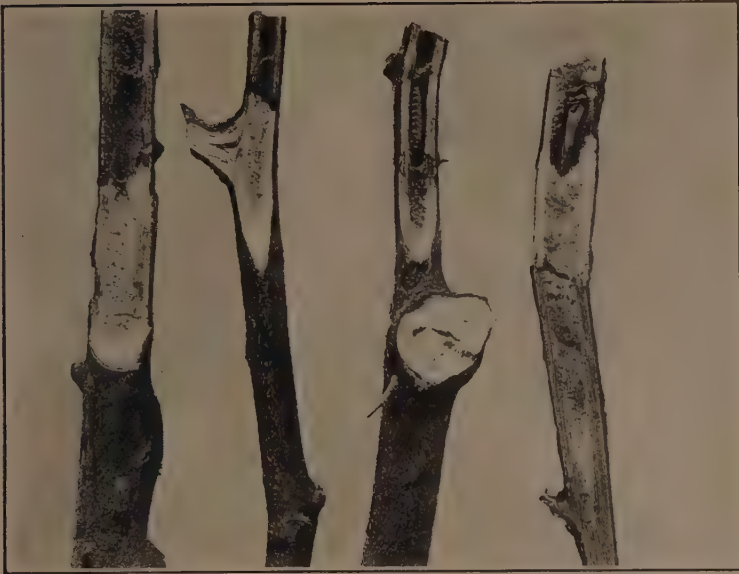
a. *Lepidosaphes newsteadi* Sulc. on umbrella pine, four times enlarged.



b. Cactus scale, *Diaspis echinocacti* Bouché var. *cacti* Comst., twice enlarged.



c. *Leucaspis japonica* Cockerell. In lower figure, females on silver maple, natural size. Top figure, males on leaf of Norway maple; in middle, males on privet, both twice enlarged.



a. Imported rose sawfly. Larvæ in stubs of manetti stock imported from Europe. Natural size.



b. Linden borer, *Saperda vestita*, natural size, and its injury to young linden trees, greatly reduced.



Bermuda lily injured by mites.

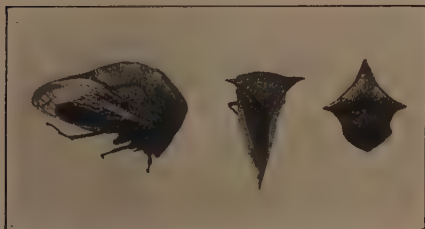
LILY BULB MITE.



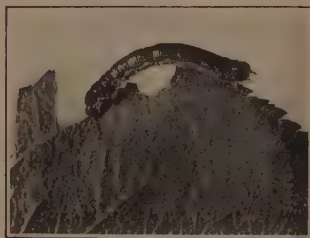
a. *Diplotaxis atlantis* Fall.,
twice enlarged.



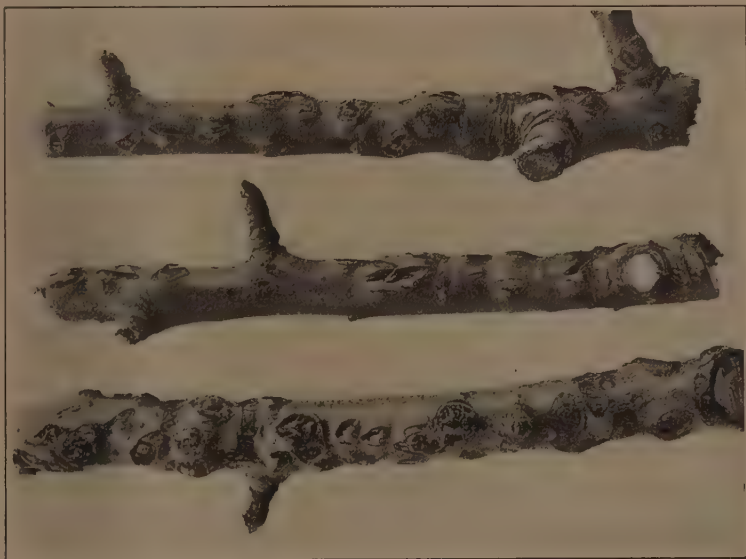
b. *Macronoctua onusta* Grote. Natural size.



c. Buffalo tree hopper, *Ceresa bubalus*
Fabr., twice enlarged.



d. Lime tree span worm, *Erannis*
tiliaria Harr. Natural size.



e. Apple twigs showing scars made by Buffalo tree hopper in laying eggs.
Natural size.



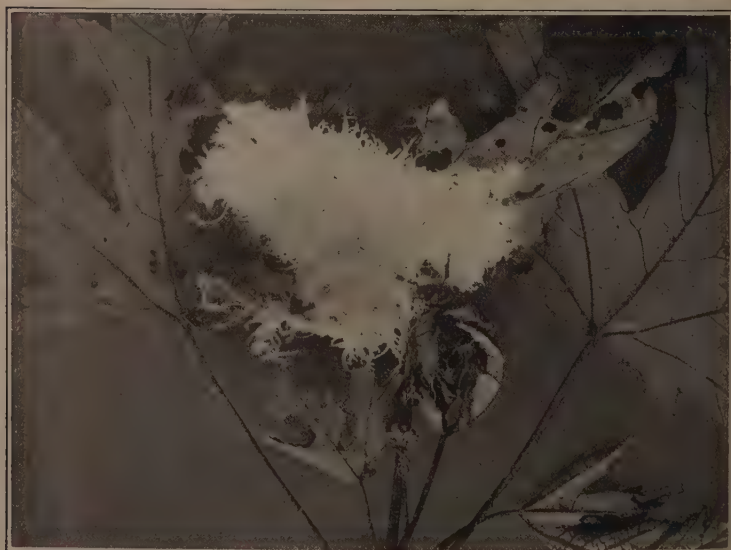
a. Marguerite daisy leaves injured by leaf-miner. Natural size.



b. Larvæ of juniper web-worm, twice enlarged.



c. Adult of juniper web-worm, twice enlarged.



d. Woolly aphids of maple. *Pemphigus tessellata* Fitch. Natural size.

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SIXTEENTH REPORT

OF THE

STATE ENTOMOLOGIST

OF

CONNECTICUT

FOR THE YEAR 1916

BY

W. E. BRITTON, PH.D.

State Entomologist

New Haven, Conn.

1917

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